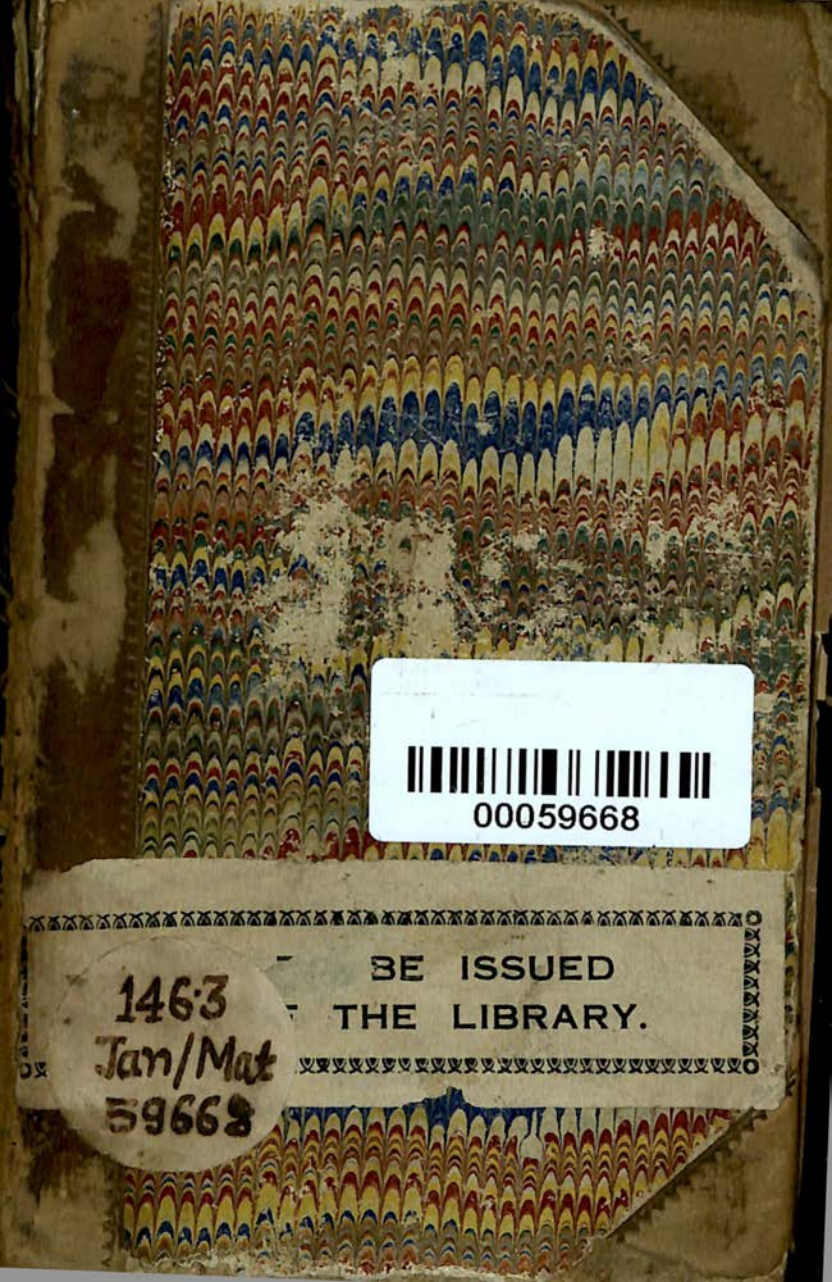
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THE

MATERIALISM OF THE PRESENT DAY.

BY PAUL JANET.

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THE MATERIALISM

OF

THE PRESENT DAY.

A CRITIQUE OF DR. BÜCHNER'S SYSTEM.

BY

PAUL JANET.

MEMBER OF THE INSTITUTE OF FRANCE, PROFESSOR OF PHILOSOPHY AT THE PARIS FACULTÉ DES LETTRES.

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TRANSLATED FROM THE FRENCH

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TRANSLATOR'S PREFACE.

Since the time when the late M. Royer-Collard dealt in France the first blow at the philosophy of the Condillac School, the Sorbonne has never lacked spirited and eloquent advocates to maintain the true principles of metaphysical science against the inroads of Sensationalism and Materialism. M. Victor Cousin, M. Damiron, M. Jouffroy may be named amongst the most distinguished; the hand of death has recently struck down M. Ad. Garnier and M. Saisset; but their places are already filled, and the standard of sound teaching is still borne aloft, despite the transient favour which the followers of Hegel and of Auguste Comte enjoy at the present time.

It is impossible to deny that doctrines considered as finally exploded are once more reappearing, favoured

by the extraordinary progress accomplished in the various branches of Natural Philosophy during the last half-century. But the very circumstances amidst which we are placed have brought forward fresh champions of the truth, and the following pages, on this account, cannot but prove interesting to our English readers.

The author, M. P. Janet, Member of the French Institute (*Académie des Sciences Morales et Politiques*), and Professor of Philosophy at the Paris *Faculté des Lettres*, is well known on the other side of the Channel by various works on ethical and metaphysical science. His admirable volume *La Famille*, published in 1857, brought him at once into reputation; and, since that time, he has never ceased, by his pen, or in the lecture-room, protesting against the errors of the modern materialist school.

It is obvious that the questions discussed in the present critique are of universal importance; they appeal to serious students everywhere, and the refutation which M. Janet gives us of M. Darwin's theory on the Origin of Species will, no doubt, be particularly noticed.

The utmost care has been taken to render this

translation as accurate as possible, and I have ventured to add, here and there, a few supplemental notes, exclusively of a biographical character.

GUSTAVE MASSON.

Harrow-on-the-Hill.

AUTHOR'S PREFACE.

The following volume is the reprint of two articles which appeared in the *Revue des Deux Mondes* during the months of August and December, 1863; articles to which I have made long and important additions. Under its present form, I think I may venture to give this work as a tolerably complete critique of Dr. Büchner's *Matter and Force*, a kind of hand-book of materialism, which has met with great success in Germany, and which, recently translated, seems to have also been rather popular amongst us. Materialism, coming back to us from Germany, is certainly one of the most singular phenomena of the times. That great country has been hitherto the favoured land of mysticism and of idealism; its acquaintance with atheism had taken place only at the supper-parties of Frederick II, the majority of whose guests were French. The Germans now send back to us that coarse system of philosophy which, a century ago, we were diffusing throughout Europe. They are weary

of passing for a set of sentimental dreamers; they want now, in their turn, to fling a stone at the soul, at God, at all old prejudices. Even whilst carrying on an undertaking so contrary to their genius, the Germans preserve still one of their traditional qualities, candour, *bonhomie*, a thorough absence of dissimulation and of hypocrisy. This is a piece of good fortune for the critic, who has only to take things such as they are told him, without the annoyance of looking under them for a double meaning. Dr. Büchner's book, besides, is far from being a contemptible production. He has very dexterously grouped and worked out the recent theories of natural and physical science, so as to make them express what they certainly *do not* contain, the demonstration of atheism. I have endeavoured to follow him on that very ground; a delicate and difficult enterprise commanded by the necessities of the day, but requiring a wider range of scientific knowledge than I have. If I could induce young *savants* in the spheres of either Natural or Moral Philosophy to follow the track I have marked out, and to give both completeness and precision to what is here only imperfectly indicated, I might perhaps have done some service either to metaphysics or to science, properly so called.

To what cause must we ascribe this revival of materialism, already so extraordinary in Germany, and the progress of which is so striking here? Shall we say, together with the materialists, that the cause is the return to experience, to the observation of facts; in one word, to the true scientific method? Of course not; for immediate experience says nothing about the validity of materialism; it is not the part of experience to ascertain first principles; and those who affirm materialism must make use of argumentation, of hypothesis, and of induction quite as much, at any rate, as those who hold the contrary view. No, the fact which explains the success of materialism, is an inclination, natural to the human mind, and very powerful just now, viz.: the inclination to unity. People want to explain all things by one single cause, one single phenomenon, one single law. This tendency is, no doubt, a useful and necessary one; without it, no science would be possible; but of how many errors is it not the source? How many imaginary analogies, how many important omissions, how many fanciful creations have resulted in philosophy from the love of a useless simplicity? No one denies, of course, that unity is the ultimate substratum of things, both at the beginning and at the

end. No one denies that one and the same harmony governs the visible world and the invisible world, bodies and spirits. But who tells us that the harmonies, the analogies which unite the two worlds together are of the kind of those we can imagine? What justifies us in compelling nature to be nothing else except the eternal repetition of itself, and, as Diderot says, one same phenomenon indefinitely diversified? Illusion and pride! Things are deeper than our mind. No doubt, matter and mind must have a common reason in the thought of God, and there it is that we should seek their ultimate unity. But what eye has penetrated so far? Who can imagine he has explained that origin common to all creatures? Who can do so except Him who is the Reason of everything? Above all, what weakness, what ignorance it is to limit the real existence of things to those fugitive appearances which our senses perceive; to take our imagination as the measure of creation, and to worship, as the new materialists do, not even the atom which had, at least, some semblance of solidity, but a *je ne sais quoi*, nameless in every language, and which we might call *infinite dust!*

March 15, 1864.

THE

MATERIALISM OF THE PRESENT DAY.

I.

GERMAN PHILOSOPHY SINCE HEGEL.

A great revolution has taken place in German ideas since the days when Kant, Fichte, Schelling, Hegel, and Herbart inaugurated with so much brilliancy the philosophy of the nineteenth century. Just now, these illustrious men, whom slow-going radicals offer to our admiration as the models of free-thought and of generous boldness—these men are, on the other side of the Rhine, considered as superannuated, and scarcely obtain the slightest mark of respect. They are viewed in the light of official metaphysicians; some even go so far as to apply to them the epithet *quack*. Listen to the gloomy, the pessimist Schopenhauer, who, in our far west, in our active and commercial town of Frankfort, has taken the fancy of reviving the *Nirvana* of the Buddhists; listen to him when he speaks of

Hegel and of the Hegelians. "Pantheism," he says, "has fallen so low, and has led to such nonsense, that people have finally worked it as a means of livelihood for themselves and their families. The chief cause of this degradation has been Hegel, who, although a man of less than ordinary capacity, has wished, by every possible means, to pass for a great philosopher, and has succeeded in being looked upon as an idol by a few very young men, at first corrupted, and now for ever narrowed in their intellect. Such attempts against the human intellect cannot remain unpunished." The same philosopher calls Fichte, Hegel, and Schelling *the three sophists*, and gives, as follows, a kind of prescription which represents the teaching of these metaphysicians and their disciples—"Dilute a minimum of thought into five hundred pages of nauseous phraseology, and trust for the rest to the truly German patience of the reader." Thus speaks Schopenhauer, who has been for the last ten years the most popular philosopher in Germany.*

Listen now to Dr. Büchner, the author of the book entitled *Force and Matter* (*Kraft und Stoff*) and one of the most decided and popular adepts of the materialist school:—"We shall set aside," he says, "all the philosophical verbiage by which our theoricians shine, chiefly the German philosophy,

* See on this philosophy the curious book of M. Foucher de Careil, *Hegel and Schopenhauer*, from which our quotations are borrowed.

which inspires a legitimate disgust in men both learned and illiterate. The days are past when learned jargon, metaphysical quackery, and intellectual legerdemain enjoyed popularity." The same writer speaks with the greatest contempt of the "pretended novelty" of German philosophy. "Our modern philosophers," he adds, "are fond of *heating up old vegetables*, and then serving them under new names as the last invention of the philosophical kitchen." These coarse denunciations prove one thing: it is the fate of all those who have reigned for an instant to be in their turn insulted and despised, and the pantheist and idealist teachers are not more respected now in Germany than the spiritualist ones are in France.

But when we think that Germany is the country of pure speculation, of abstract thought—the country where the universities seemed to be, until lately, at the head of every scientific movement—how can we account for the fact that, there, persons have come to speak in so rude a manner of illustrious philosophers, lately worshipped, and of university teaching, always surrounded by such respect? This is not one of the least curious symptoms in the philosophical tendencies of the present day. But we must trace things a little further back.

When Hegel died, in 1832, never did a conqueror leave an empire more extensive and apparently less contested. He had reduced to silence all rival voices, even that of his master and competitor, the

illustrious Schelling. Herbart alone had managed to preserve his independence, but no one listened to him—his turn had not yet come. The profound and bitter Schopenhauer was beginning to protest in solitude at Frankfort, and, for a long time, he had to struggle against the indifference of the public. Humboldt enjoyed, with a few friends, his joke on what he called the dialectic tricks of Hegel, whilst in the world he treated that school with the respect he displayed towards the "powers that be." In the midst of this universal silence, the school of Hegel had invaded everything—the universities and society, the church and the state. A common formulary was adopted in all the schools. It seemed as if a new church had been founded.

No philosophical creed, however, has at any time proved of long duration. After the first moment of superficial agreement, when minds animated by a community of sentiment, and not having yet sifted their own ideas, come to a *verbal* understanding, for want of directing their attention towards *things*—after the first impression of awe produced on second-rate intellects by the ruling authority of genius, each one by degrees recovers the possession of himself, and seeks to understand what he professes. After faith comes interpretation, and when interpretation appears, the prestige of unity vanishes—heresies begin. That is what happened soon to Hegelianism; men developed their views, and from that time all agreement was at an end.

Three different interpretations were given by the disciples of Hegel to their master's philosophy: one in the spiritualist and religious direction, another according to the naturalist and atheistic sense, whilst between them a third school endeavoured to maintain the lofty, conciliatory views of the teacher himself, and to hold the balance equal between spirit and nature. Theism, Pantheism, and Atheism—such were the three doctrines which divided amongst themselves the inheritance of Hegel. These three sections of the school were called by names borrowed from the vocabulary of politics—the *right*, the *centre*, and the *left*, soon followed by the *extreme left*. As early as 1833 these schisms were in course of preparation—in 1840 they were accomplished.

Of these three fractions of Hegelianism, the most powerful, the one which gave the greatest impulse to the public mind, was evidently the most radical, the most energetic—that is to say, the left and the extreme left. The former represented, in the first instance, by Michelet of Berlin, and by Dr. Strauss, endeavoured especially to develope its views on the personality of God and the immortality of the soul. Its members established the two following points of doctrine, which have become so celebrated in Germany, viz., that God is personal only in man, and that the soul is immortal only in God; in other words, that neither God is personal nor the soul immortal. However, this subdivision of the school still remained faithful to the Hegelian spirit

in distinguishing idea from nature, logic from natural philosophy, spirit from matter. The extreme left, on the other hand, attacked all these scholastic distinctions. What is the use, they said, of Hegel's logic, which only expresses for the first time in an abstract form the fact realised by nature in a concrete one? Why should we distinguish idea from nature? The idea is nature itself. Once on this declivity, there was nothing that could prevent the neo-Hegelians from returning purely and simply to the materialist and atheistic doctrines of the eighteenth century, and this is what the Hegelian extreme left did in the writings of Messrs. Feuerbach, Bruno Bauer, Max Stirner, Arnold Ruge.* Even then the first-named of these gentlemen preserved a kind of religion, analogous to that of the Positivist school—the worship of mankind. "Man alone," exclaimed he, "is the true Saviour. Man alone is our God, our judge, our redeemer! But the disciples went further on, refusing to acknowledge even that God-mankind, and the worship which they called *anthropolatry*. M. Max Stirner attacked Feuerbach's mankind-worship as a last superstition, and preached *autolatry*, or self-adoration. "Each one is to himself his own God," said he—*Quisquis sibi Deus*. "Each one has a right to everything"—*Cuique omnia*. Another disciple of the same school, M. Arnold Ruge,

* M. Saint-René Taillandier is the first writer who has made known in France this remarkable deviation of Hegelianism. See *Revue des Deux Mondes*, the number for July 15th, 1847.

founder of the *Annals of Halle*, which was the journal of the sect, said that "Atheism is still a religious system; the atheist is no more free than the Jew who eats a slice of ham. We must not struggle against religion—we must forget it." In order to have an adequate idea of the kind of anti-religious rage which animated the neo-Hegelians, we should read over again the works of some of the French atheists of the last century: Naigeon, Lalande, Sylvain Maréchal.*

No wonder that this fanaticism of impiety in a country which is still deeply imbued with the spirit of religion, discredited to a great extent philosophy and its interpreters. The Germans love free thought, but they respect sacred topics. You may say whatever you please, provided you make use of hieroglyphic formulæ inaccessible to the multitude; but this was precisely what the young Hegelians got tired of; they wanted to speak loud and distinctly, to call things by their names; and they were not afraid of using the coarsest and grossest language. This is not all. In the sphere of politics as well as in that of philosophy, they professed the most radical doctrines. 1848 arrived. The Hegelian extreme-left became the revolutionary extreme-left; atheism and socialism shook hands; thus was increased the repulsion which Hegelianism

* Jacques André Naigeon (1738-1810); Pierre Sylvain Maréchal (1750-1803): Joseph Jérôme Lalande (1738-1807); see on these three representatives of French atheism, M. Damiron's *Mémoires sur la Philosophie du* 18e *siècle.*

inspired, and of which philosophy was to feel the effect. The reaction of 1850 struck metaphysics down in Germany as well as in France. Public opinion abandoned the world of thought, silence reigned around the universities, then occupied by second-rate men, some of whom, however, were distinguished, especially as critics. All these facts can be the more easily understood, because they found their counterpart on this side of the Rhine.

But silence and peace do not belong to this world. Conquered with the revolution, fettered in the universities, forgotten apparently by the public, metaphysical speculation soon began to revive. Neither the human mind nor the German mind can live without philosophy; but the revival took place in the direction where it was least expected, in that of natural science. It is, in fact, the positivist school which has profited from the penitential *régime* inflicted to the philosophy of the universities. Those who aimed at keeping under restraint a free spiritualism have flung open to materialism a gate which it has entered without the slightest opposition.

One of the first symptoms of the awakening of philosophy in Germany was the unexpected success of a thinker already old, who, for more than twenty years had been writing in the midst of public indifference, and of whom we have quoted a few sayings full of humour and of misanthropy—we mean Schopenhauer. The incontestable originality of that writer, his style full of brilliancy and of

bitterness, clearer than is the case in the majority of German works, his sharp denunciations of scholastic philosophy, the eccentricity of his misanthropy and his pessimism, a kind of proud and supercilious atheism which reminds us of Obermann*—in short, his qualities and his defects were tolerably in accordance with an epoch of mental weariness, when neither faith nor philosophy gave any satisfaction, the former not having yet recovered from the wounds inflicted by Dr. Strauss, and the latter being discredited by the abuse of scholastic formalism. The German schools, smitten in the first instance by reaction, were now suffering from the attacks of free and individual speculation; the same thing, too, had occurred in France, where the schools, proud of having encountered the animosity of the reactionary party, thought themselves naïvely the depositaries and the organs of philosophical liberalism—when all of a sudden they saw themselves attacked from without by the critical and positivist movement, on the one side, and, on the other, by the Hegelian onset retrograde there, but revolutionary here; thus it is that we French spiritualists have been obliged to pass suddenly, and without preparation, from the left to the right.

However, the success of Schopenhauer's philo-

* Name of a celebrated novel by the late M. de Sénancour. A new edition of this book, with a preface from the pen of George Sand, was published a few years ago in Paris. 1 vol. 18mo. Charpentier.

sophy seems to have been, in Germany, merely a transient crisis. This philosopher belonged still too much to the party which he attacked. He was an idealist, evidently connected with Kant, nay, even with Fichte, and from that point of view his doctrines were certainly superannuated. Where is the time when one could seriously write and make people believe axioms like this: "I am because I will to be?" Besides, one need be thoroughly versed in the mysteries of metaphysical phraseology to understand the difference which exists between the *absolute will*, which is, according to that philosopher, the essence of the world, and the *absolute idea* of the Hegelian school. A will without conscience and an idea without conscience seem to me very much alike, and are nothing else but the instinctive and immanent activity of the absolute being.

It is in an order of ideas more positive that Germany went forth in quest of a philosophy. Physiology and the natural sciences supplied the desideratum. During the whole time when the doctrine of identity had reigned, the inductive sciences had remained isolated, and in an attitude of reserve; a few great *savants*, even, Œrsted, Oken, Burdach, Carus, and Müller himself, were under the *prestige* of idealism. Protestations had, however, been entered in the name of experience, and Göthe, who although a poet, was a *savant* as well as a poet, had clearly seen the defect of the speculative method, and of *à priori* science. "It is nearly thirty years," said he,

"since the Germans have been making transcendental science. If they once become aware of it, they will find themselves very ridiculous." And yet the empire of philosophy was so great that it arrogated to itself the right of treating with the utmost contempt the objections of empiricism. If it was reproached for its inability to explain particular facts, Michelet of Berlin arrogantly replied that "such explanations were not above science, but below it." Only those who have power on their side can make answers of this kind, but one day they are sure to have to account for them. That is what has happened in Germany to the philosophy of nature. "The disfavour with which this system is viewed is such," says Büchner, "that the name of philosophy of nature in the scientific world is hardly anything else but an expression of contempt." The natural and positive sciences have taken possession of the sceptre which the idealist school of philosophy had been obliged to yield; they have, in their turn, had their philosophy, which, we must say, is purely and simply downright materialism. M. Moleschott has been the leader and propagator of that movement.

There is no doubt that Moleschott's school gives the right hand of fellowship to that of Feuerbach. The one has rendered the other possible, but there is between them a great difference, arising from a difference of origin. Feuerbach's school is originally Hegelian—it has sprung from dialectics. Of course it leads to materialism, but by deduction, by the logical concatenation of ideas. It is an abstract

materialism, blended with an atheistic fatalism and political passions and illusions mixed up together. M. Proudhon represents pretty accurately, in France, that kind of philosophy, fond of arguing, violent and chimerical.* The materialism of Moleschott and of his friends, is quite different in its character—it is a physiological materialism, founded upon science, positive knowledge, and experience. The new school resembles more that of Cabanis, Broussais, and M. Littré.† The revolutionary spirit was that which animated Feuerbach; Moleschott is guided by the positive spirit, the spirit of science. In short, we are called upon to witness the retaliation of empiricism against the frenzy of *à priori* rational speculation.

The first book in which the doctrines of the new school are explained is Moleschott's work, entitled *The Circular Course of Life* (*Kreislauf des*

* On M. Proudhon and his doctrines, see the volume entitled *Publicistes modernes, par M. Henri Baudrillart, Professeur au Collège de France.* Paris, Didier.

† Pierre Jean Georges Cabanis (1757-1808) was one of the most brilliant disciples of Condillac. His *Rapports du physique et du moral de l'Homme*, Paris. 2 vols. 8vo. 1802, may be considered as his chief title to fame. A physician like Cabanis, François Joseph Victor Broussais (1772-1838) published in his *De l'Irritation et de la Folie*, the most unblushing manifesto of the sensationalist school, Paris, 1 vol. 8vo. 1828, on these two writers see M. Damiron's *Essai sur l'Histoire de la Philosophie en France au 19e siècle.* Third Edition, Paris, 1834, 2 vols. 8vo. M. Littré is the best representative of the Comtean, or positivist philosophy; see on him M. E. Caro's *l'Idée de Dieu et ses nouveaux critiques*, Paris, 1865, 1 vol. 8vo.

Lebens), the first edition of which bears date 1852, whilst the last (fourth) was published in 1862. It is a series of letters addressed to the celebrated Liebig on the principal subjects of philosophy—the soul, immortality, liberty, final causes. In that book Moleschott lays down the startling axiom of new materialism, "Without matter no force, and without force no matter." He maintains the hypothesis of an indefinite circulation of matter, passing on unceasingly from the world of life to the world of death, and *vice versâ*, and he exalts what he calls the all-mightiness of the transmutations of matter. (*Allgewalt des Stoffenwechsels.*)

Moleschott's volume created a great sensation in Germany, and shook minds out of their philosophic lethargy; but the fact which determined especially the outbreak between materialism and spiritualism was the discourse pronounced in 1854 at Göttingen, before the congress of German physicians and naturalists, by M. Rodolph Wagner, one of the most eminent physiologists in Germany. In that discourse, entitled, *On the Creation of Man and the Substance of the Soul*,* M. Wagner examined the following question, "What have the last results of physiology determined respecting the hypothesis of an individual soul essentially distinct from the body?" For his own part, he declares that nothing in these results leads him necessarily to acknowledge a distinct soul; but he adds that the moral law requires such an hypothesis. In another writing,

* *Menschenschöpfung und Seelensubstanz.* Göttingen, 1854.

published for the purpose of explaining his lecture, and entitled *Science and Faith* (*Wissen und Glauben*), he draws a clear distinction between these two domains, and says, "In matters of belief I like the charcoal-burner's simple and naïve faith; in scientific matters I place myself amongst those who are fond of doubting as much as possible."

This appeal to the charcoal-burner's faith called forth a spirited and bitter reply from M. Charles Vogt, a distinguished naturalist, pupil of Agassiz. M. Vogt, one of the members of the German radical party, occupied at the Frankfort Parliament one of the seats at the extreme left; he lives now in exile in Geneva, where he has become a professor and a member of the Council of State.* He joked the Göttingen professor on that twofold conscience which he was trying to secure, the one for science, the other for religion; and he compared it to "book-keeping by double entry."

But it is not only in that accidental *brochure* that Charles Vogt betrayed his materialist sympathies; it was also in writings more developed, and of a more scientific character—in his *Sketches of Animal Life* (*Bilder aus dem Thierleben*), in his *Physiological Letters* (*Physiologische Briefe*), and finally in an essay recently published, full of wit and of *verve*, *Lectures on Man, on his place in creation and in the history of the earth.* M. Vogt acquired celebrity during this discussion especially on account of the

* See A. Laugel's *Science et Philosophie* (Paris, 1862); *Les Problèmes de l'Ame*, (Paris, 1866). This article contains interesting details on the subject which is now engaging our attention.

commentary which he gave to the definition of Cabanis, "Thought is a secretion of the brain." Distrusting the reader's power of comprehension, Vogt thought proper to improve upon that coarse formula, and he informs us that "the brain produces thought in the same way as the liver produces bile and the loins urine"—a proposition so evidently false that another materialist, Dr. Büchner, has felt it necessary to refute it.

Dr. Büchner is, nevertheless, in his turn, one of the most ardent disciples of Moleschott, and one of the most decided interpreters of the new materialism. Of all the writings proceeding from that school, *Matter and Force* is the one which has obtained the greatest success. Published for the first time in 1856, it has in the course of five years gone through seven editions, and it has just been translated into French by a friend of the author, who, by the by, should have had his translation revised by some person capable of writing correctly his own language. However, his book, short and concise, full of facts, written with rapidity and clearness—new qualities for a German book—may serve as a compendium of all the others, and it contains in a few pages the substance of the whole doctrine. It is the hand-book of new materialism.

In order to have an idea, if not complete, at all events sufficiently distinct, of this singular philosophical movement, we ought to mention likewise M. Spietz, who, in his *Physiology of the Nervous System*, and in his disquisition *On the bodily con-*

ditions of the activity of the soul, has expounded a materialist doctrine which he combines, rather oddly, with a belief in revelation, a circumstance which has obtained for his system the name of *believing materialism*. There is also *The System and History of Naturalism*, by Edward Lowenthal, praised as an original production by Feuerbach, although it seems to contain nothing after all except the old atomistic theory. The most remarkable feature in it is that the author goes farther still than Moleschott and Büchner; he reproaches them for being eclectic materialists, and that, on account of their principle of the union of matter and force. If we may believe him, force is not an essential and primordial condition of matter, but only the result of aggregation. Let us name also, but with some reserving clause, M. Czolbe, for he deserves a place amongst the sensationalists rather than among the materialists, as can be seen by a reference to his *New Exposition of Sensationalism* (*Neue Darstellung des Sensualismus*). The common character of all the writings we have mentioned is to rest upon the positive sciences, and to abandon almost entirely the psychological and metaphysical method which had hitherto characterised philosophy in Germany, in France, and in England.

If materialism has produced in Germany a fruitful and powerful school, we must acknowledge that spiritualism, on its side, has raised numerous and important protests. It is especially in the ranks of philosophy, properly so called, that spiritualism has found its champions; but accomplished supporters

have also sprung on its behalf from the midst of the scientific world. We have already said that out of the wrecks of the Hegelian right side a spiritualist school had arisen of a deeply-marked character. One of the principal representatives of that school is M. Fichte, who honours a name well known in philosophy. This gentleman's *Anthropology** contains the doctrine of a non-corporeal soul, although the writer appears to admit, with Leibnitz, that the soul is never to be found without its corresponding body; but the *Anthropology* is exclusively speculative and anterior (the first edition at least) to the dispute we are at present describing. In that dispute M. Fichte took a more special part by his work on *The Question of the Soul (Zur Seelenfrage)*, which is one of the important documents in the debate. The spiritualist views are defended besides in a philosophical magazine established by M. Fichte, with the assistance of two of his friends, Messrs. Ulrici and Wirth—a magazine which is the most valuable periodical organ of philosophy now existing in Germany. It is the *Review of Philosophy and of Philosophical Criticism (Zeitschrift für Philosophie und Philosophische Critik)*, published at Halle. In this *recueil* the new materialist doctrines have been stated and attacked most vigorously in several articles from the pen of M. Zeising. One of the conductors of the review, M. Ulrici, professor at Halle, has also developed the spiritualist ideas from

* *Anthropologie, die Lehre der menschlichen Seele.* Leipzig, Second Edition. 1864.

the religious point of view in his beautiful book entitled *God and Nature* (*Gott und Natur*, Leipzig 1862.) Spiritualism has, moreover, found recruits in the school of Herbart, of which M. Drobisch is now the chief representative. To the same doctrine may be ascribed, although they are not directly mixed up with the present quarrel, M. Ritter, the great historian of philosophy, and M. Trendelenburg, one of the staunchest adversaries of the Hegelian theory, and whose *Logical Researches* deserve to be ranked amongst the most remarkable books recently produced by German philosophy. In considering the metaphysicians who have especially and directly attacked Messrs. Moleschott, Büchner and Vogt we must mention M. Jules Schaller, author of *Body and Soul*,* a treatise to which he has since added a work of a less polemical and more scientific character on the *Spiritual Life of Man*;† M. Drossbach, author of *The Essence of Individual Immortality*: Dr. Michelis (*Materialism proclaimed the faith of the common people*); M. Robert Schellwein of Berlin (*The Critique of Materialism*); M. Tittman, of Dresden; M. Karl Fischer, of Erlangen, &c. Those who have defended the doctrine of the soul from the stand-point of positive science deserve a distinct mention—amongst them, in the first rank, an eminent physiologist, M. Lotze, who in two celebrated works (*Medical Psychology*‡ and *The Microcosm*§), has maintained the spiritualist point of view.

* *Leib und Seele.* Weimar, 1858. Third Edition.
† *Das Seelenleben des Menschen.* Weimar, 1860.
‡ Leipzig, 1852. § Leipzig, 1850.

M. Lotze returns to the Cartesian dualism, and seems disposed to grant that the laws of life ought to be reduced to those of natural philosophy, chemistry, and mechanics; but he separates the thought from the body; to the soul alone he allows the legislative power, whilst the executive resides in the body. With reference to the explanation of matter itself, M. Lotze adopts the monadological hypothesis of Leibnitz and Herbart, which he wishes to adapt to the results of modern science.

From these few details it will be seen that both camps are rich in learned, impassioned, sincere champions. If we could forget that it is the dearest interests of mankind which are the subject of everlasting disputes, one would feel a noble joy in seeing such deep questions exciting on either side the energy of so many men of science and of talent. These great efforts to solve problems of so much importance will always be reckoned amongst the noblest sources of activity for the human mind. It is in vain that we are invited to forget such immortal problems—in vain are we told to look at our feet and not beyond; the thirst for the invisible and unknown can never be extinguished in us. Even those who reduce everything to matter have the pretension of knowing things to their very depths, and of tracing them back to their first principles. Whilst she digs deep, as she has done for the last ten years, into the problem of mind and of matter, Germany continues worthily the philosophical traditions in which she has so long held

the foremost rank. The season of great metaphysical constructions seems past, just now, at least. Metaphysical science is struggling with reality, with the positivist tendencies of the age. Will it triumph?—will it succeed in maintaining the idea of spirit at a time when matter seems to triumph on all sides? Such is the question at present discussed in Germany, and in France, too, simultaneously, though under another shape. For everyone cannot but observe that the phases we have just described offer great analogies with those which French philosophy has gone through since 1848. The increasing progress of naturalism amongst us is no longer a mystery. Nevertheless, we must say that, despite the irresistible tendency which hurries it on to its necessary consequences, the French naturalism has not yet dared to hoist boldly the standard of materialism, and that it even professes loudly not to do so. It is clear that non-spiritualist philosophy in France holds very nearly the same position which the Hegelian left side occupied in 1840. Michelet of Berlin, Strauss, even Feuerbach have amongst us representatives whom it is useless to point out. As for Moleschott and Büchner, we could hardly name their parallels except by alluding to some of the forlorn hope of the positivist army, who affirm and decide with boldness where the master had recommended to maintain an absolute reserve. Our critique is thus directed against Germany rather than against France; every reader, however, may apply it as he thinks fit.

II.

DR. BUCHNER'S SYSTEM STATED.

The principle of the new materialist school is expressed by Dr. Büchner as follows: "No force without matter, no matter without force." Force, according to M. Moleschott, is not a God giving impulse to matter; a force brooding over matter is an absurdity. Force is the property of matter, and cannot be separated from it. Try and represent to yourself a particle of matter without force—for instance, without force of attraction or of repulsion, of cohesion or of affinity; the very idea of matter disappears, because it would be impossible for it to be in any determined state. *Vice versâ*, what is a force without matter, electricity independent of electrified particles, attraction without molecules attracting one another? "Can anyone maintain," says Vogt, "that there exists a secretory faculty independent of the gland, and a contractile faculty independent of the muscular fibre?" These are mere abstractions. In a word, as the learned Berlin physiologist, M. Dubois-Reymond ingeniously remarks, "Matter is not a coach to which you could fasten or from which you

could remove forces as if they were horses." Each material molecule has its inherent and eternal properties, which it carries everywhere with it. "A particle of iron," says the same writer, "is and remains the same, whether it goes through the world in an aërolite, or rolls like thunder on a railway, or circulates in a globule of blood through the temples of a poet." It follows from these principles that the idea of a creative force, of a force absolute, distinct from matter, creating it, governing it, according to certain arbitrary laws, is a mere abstraction. It is an occult quality transformed into an absolute being.

Thus matter and force are inseparable, and they have co-existed from all eternity. Immortality of matter, immortality of force, such is the second principle of the philosophy we are explaining. The immortality of matter, long ago guessed at by science, has now become a positive truth since the admirable discoveries of chemistry. Chemistry has proved that the same quantity of matter always exists, whatever may be the various combinations which it effects. This great result has been obtained through the use of scales. Burn a piece of wood, and the chemist's weights will tell you that not a particle of matter is lost; nay, the weight has increased by a certain quantity which the air had lost. In all the compositions or decompositions of chemistry there is always equation between the elements and the produce, and *vice versâ*. Chemistry demonstrates, besides, that the various substances always preserve

the same properties. Thus matter never perishes, but it is in a state of perpetual motion; as Heraclitus the Ephesian said, it is an ever-living fire,* a game which Zeus is eternally playing with himself. It is an unceasing circulation of materials, of which each accidental combination begins and ends; but under one shape or another the materials are always there.

> "Imperious Cæsar, dead and turned to clay,
> Might stop a hole to keep the wind away."

Thus nothing comes from nothingness—nothing returns to nothingness. The old axiom of the atomistic philosophy is proved.

It is the same with force as with matter; it is immortal, it becomes transformed, but it does not perish. "That which disappears on one side," says the illustrious Faraday, "necessarily re-appears on the other." One of the finest and most signal applications of this principle is the transformation of heat into movement, and reciprocally. By friction, heat is obtained—and by steam, motion. The quantity of motion lost is compensated by a quantity of heat; the quantity of heat lost is found again in a quantity of motion. Thus force is preserved as well as matter, and this can be determined beforehand. From these remarks we must conclude that matter and force have not been created, because that which cannot be destroyed cannot have been created. Reciprocally, everything which has a beginning must have an end. Thus

* See Heraclit. *Fragment.* No. 27, Didot's edition, p. 318, and Diog. Laertius, lib. IX, cap. I., sect. 6.

matter is eternal, and it alone has this quality: sprung from dust, to dust we shall return. Not only is matter eternal, it is likewise infinite—infinite in smallness and in greatness. The microcosm and the macrocosm are both infinite. Here Dr. Büchner speaks like Pascal, but with less vigour. Who does not remember the splendid passage on the two infinitudes, where Pascal has displayed all the richness and all the grandeur of his wondrous eloquence?* Who has not present in his mind, on the one hand, that infinite sphere the centre of which is everywhere, while the circumference is nowhere, and, on the other, that worm which contains worlds *ad infinitum?* The new German philosophy is distinguished from the old materialist school, because it admits divisibility *ad infinitum.* The atom is merely a representation of the imagination. Neither observation nor reason can lead us to it. The idea of infinite divisibility frightens our mind; but we cannot help it, we must be satisfied to admit what is incomprehensible.

Matter being eternal and infinite, it follows, manifestly, that its laws are universal and immutable. This is evident from our previous observations, for the laws of matter result from its properties. "The laws are the necessary relations which result from the nature of things." Now, the properties of matter are eternal as matter itself; hence its laws are immutable. If its laws changed it would be owing to a change in its

* *Pensées*, M. Havet's edition, p. 1-8.

properties, or because it assumed properties contrary to its essence, which is impossible. Besides, we can call in here the testimony of experience. The laws of nature have never undergone the slightest change. Miracles take place only for ignorant people, and in their presence. Savage hordes, highland tribes, and classes of society insufficiently enlightened, see miracles; for civilised ages, large cities, centres of politeness and unbelief, there are none. Thus, we admit no supernatural intervention, no accidental and contingent action of a supreme cause.

I know not who has said, "The heavens do not declare the glory of God; they only declare the glory of Newton and Laplace." Dr. Büchner would willingly accept this maxim. According to him, in proportion as the science of the world has progressed, in the same proportion has the idea of creative, supernatural, providential force been every where driven back to the skies; nowadays we see nothing but a mechanical, mathematical law, resulting from the very nature of matter, and explaining all phenomena conformably to the principles of geometry and mechanics. Let us now leave heaven and alight on earth. Here again there is no immediate intervention of the deity; science tends more and more to demonstrate that the great revolutions which have disturbed the surface of the globe have been produced by causes similar to those which we know at the present day. Time here is the great creator. Dr. Büchner, we see, admits, as perfectly demonstrated, Sir Charles Lyell's

geological system—the system of slow action. The days of creation are nothing more than the insensible evolutions of a continuous action. At most, can we admit that the action of the forces known to us have at certain moments manifested themselves with a greater power. Now, here is the grand problem:—Has there not been a time on the globe when a force absolutely new made its appearance—the force of life? How can we explain the primitive generation? Everything agrees to compel us to admit that life is only a special combination of matter, and that this combination took place as soon as favourable circumstances were produced. For, as soon as these circumstances occur, life manifests itself, and to each change of medium corresponds an equivalent and proportionate change in the forms of life. To each stratum of the earth's crust corresponds by gradation a living world: to the most ancient are consigned the most imperfect forms, to the most recent belong the most complicated. When the sea covered the continents everywhere, nothing could exist besides fishes and aquatic plants. As it became formed, the continent was clothed with forests which absorbed the mass of carbonic acid necessary to plants, but hurtful to the animals which filled the air; deprived of that noxious gas, the atmosphere became fitted for the respiration of animals. Thus everything seems to indicate that organic forms are the resultants of the medium and external conditions in which they are placed.

Dr. Büchner and the German school in general admit, then, without hesitation, spontaneous generation. Wherever air, heat, and damp combine their activity, there are produced, with a certain rapidity, those innumerable microscopic animalcules which are called *infusoria*. Dr. Büchner, however, is somewhat moved by the numerous and very cogent reasons adduced against the theory of spontaneous generation. He gets out of the difficulty with the help of an hypothesis. According to him, we might suppose that the germs of all living beings have existed from all eternity, and have awaited, in order to develop themselves, the production of favourable circumstances; these germs, scattered through space, came down upon earth after the formation of the solid crust, and were brought out as soon as they found their necessary media.

Despite that hypothesis, Dr. Büchner scarcely conceals his leaning towards spontaneous generation; he no less, and one could foresee it, advocates the idea of the transformation of species; for whatever share we may feel disposed to grant to the creative powers of matter, it is difficult to maintain that nature has been able to produce spontaneously a man, a horse, an elephant, especially for those who say that nature has never acted, except through forces like unto those with which we are acquainted. Therefore, if a man is decided to set aside the hypothesis of a creative power and of a providential interposition, he is led to suppose that all

organic forms have sprung from one another by imperceptible modifications. The following are the two facts upon which our author particularly rests: the germ is alike in all species, and the animal, as he developes himself, passes through all the inferior forms of the animal kingdom, or, at least, he represents, at the different stages of his development, the principal types of the series. Fossil animals seem to be nothing else but the embryos of living ones. Agassiz has demonstrated this for fishes, and he is of opinion that the same truth applies to all the other classes of animals. From both these facts why may we not conjecture that the animal kingdom has begun with the most general, the most embryo-like forms, and that, by degrees, under the influence of external circumstances, these general forms have been modified and diversified?

Dr. Büchner's work is anterior to the celebrated book of Mr. Darwin on the Origin of Species, otherwise he would not have failed to make use of the English physician's researches, in order to support his own theories; but he quotes him admiringly in a note of the last edition, telling us that he did not suppose that science would so speedily confirm his conjectures, and support his assertions with the most decisive proofs. Mr. Darwin helps him especially to solve the difficult problem of the adaptation of forms to the medium in which these forms exist—in other terms, the problem of final causes.

It may be foreseen that modern materialists as

well as the old ones declaim most energetically against final causes—against the hypothesis of a pretended design in nature. Everything, it is asserted, has been made in nature with a view to the use of man. But, then, how do you account for the existence of noisome animals? Divines in all ages have had recourse to the most comic suppositions for the purpose of explaining the creation of such beings. What is the use of illness, and, generally speaking, of all physical evils? Theologians tell us that disease is the result of sin; but this is an error caused by ignorance. Disease is as old as organic life; palæontology shows us many bones of animals altered by disease.

The colours of the flowers are intended, it is said, to charm our eyes; but how many flowers have bloomed and will bloom without having been admired by eye of man. Great stress is laid upon the use of the several organs and their adaptation to the various ends for which they were made; but comparative anatomy points out to us a large number of organs superfluous and rudimentary, which, useful for one species, are quite useless for others: thus, the rudimentary breast of man, the teeth of the whale, &c. Some hermaphrodite animals have the organs of both sexes, and yet are incapable of self-fecundation. What is the use of such a complication? Monstrosities are another decisive proof against final causes. There are animals which, perfectly made in other respects, are born without a head, and for which, therefore, life

is impossible. Is it not absurd that nature should take the trouble of producing such beings, which are quite useless? The *vis medicatrix* is invoked; but what is the use of physicians, if nature, unaided, can cure itself? And how often do not physicians see in diseases, in wounds, nature acting in the wrong direction and imperilling the patient! Why, says M. Littré, does not nature warn us when we swallow a poison? Why does she not throw it up? Why does she introduce it into our system, as if it was a useful food? Why, finally, when the poison is absorbed, does she determine convulsions which, far from being of any use to the patient, carry him off?

But if there is not in nature a power acting comformably to an end, how are those adaptations produced which strike us with wonder? According to Dr. Büchner, it is by the energy of the elements and forces of matter, which in their fated and accidental concurrence must have produced innumerable forms, which must needs limit each each other mutually, and correspond apparently the one with the other, as if they were made for that purpose. Out of all those forms, they alone have survived which were adapted, in some manner, to the conditions of the medium in which they were placed. How many unfortunate attempts must have been made and must have failed, because they did not realise the conditions necessary to their existence!

It is here that Mr. Darwin's book happily comes

to the help of Dr. Büchner, and supplies him with the principle he stands in need of to explain the disappearing of certain species, and the preservation of the rest. Mr. Darwin's system rests upon two axioms, viz., that of natural selection and that of the struggle for life. All living species fight for food: all contend for self-preservation and supremacy. That state of war which Hobbes supposed to exist only between primitive men, is the universal law of animal life. In the struggle, the slightest advantages may help to give superiority to the one over the other—to secure the preservation of certain forms, and the disappearance of those which were less favoured. The adaptation to a certain end is accordingly a result merely, and not a design; it is the result of certain natural causes which have accidentally brought about these various adaptations.

After having endeavoured to prove that the active force of nature cannot be separated from nature itself, the materialists employ analagous arguments against that other force which we call soul, and which, according to them, is only a mere function of our organism.

If there is a proposition evident for the physiologist and the physician, it is this: the brain is the organ of thought, and the one is always in the same proportion as the other. The development of the intellect is in proportion with the size, the shape, the chemical composition of the brain. Let us speak first of size. The animals which have no

brain, or only a rudimentary one, are placed at the lowest degree of the intellectual scale. If a few animals seem to have a brain larger than that of man, it is owing principally to the development of the parts which preside over the functions of relation and of sensation; those connected with the special functions of thought are smaller than in man. The shape of the brain is not a less interesting subject of study than its size. The variety of intellects has been accounted for likewise from the cerebral anfractuosities or circumvolutions. Professor Huschke has proved that the intellect of the animal species is in proportion with the number of cerebral sinuosities. According to the celebrated Wagner, who has dissected Beethoven's brain, this organ presented anfractuosities both more numerous and deeper than those of ordinary brains. The striæ of the brain, which are scarcely perceptible in children, expand in adults, and with them intellectual activity increases. These data are confirmed by observations made on insanity, madness, or idiotcy. · According to Dr. Parchappe, the weight of the brain diminishes in direct ratio as the amount of insanity. Cretinism always proceeds from a malformation of the brain. Most physicians agree in recognising that the majority of cases of insanity correspond to morbid alterations of the brain; and if it has been impossible to ascertain these alterations in all cases, it is no doubt on account of the imperfection of our anatomical resources. The same observation applies to the comparison between

the different races of men. What a contrast there is between the skull of a negro and the noble, well-developed cranium of the European races! If the intellect is in direct ratio as the brain, the converse proposition is not less true. The development and the exercise of the intellect develope the brain, just as much as the exercise of the wrestler strengthens the muscles. If modern skulls are compared with ancient ones, it will appear beyond doubt that the skulls of Europeans have considerably gained. The older the type, the larger is the expansion of the occipital part, and the greater is the flatness of the frontal portion. Hatters know by experience that the cultivated classes require larger hats than the lower classes.

As for the chemical composition of the brain, it is much less simple than some persons have believed; and it contains complex substances which are found nowhere else, such as cerebrine, &c. Certain fatty matters seem to have a great importance in the cerebral organ. There, also, phosphorus plays a conspicuous part, and Moleschott was able to say, "Without phosphorus, no thought."

Whilst admitting that the soul or thought is an organic function, and nothing else, Dr. Büchner nevertheless combats the well-known doctrine of Cabanis, that "the thought is a secretion of the brain;" doctrine which another materialist writer saw fit to revive in the following terms: "there is the same relation between thought and the brain, as between bile and the liver, between urine and the loins." Dr.

Büchner condescends to acknowledge that the comparison is not a happy one, "for," says he with truth, "urine and bile are substances palpable, ponderable and visible; they are, besides, excrementitial matters which the body has used and which it throws off, whilst thought is not a substance which the brain uses and throws off; it is the very action of the brain. The action of the steam-engine must not be confounded with the steam which the engine throws out." Thought is the resultant of all the forces united in the brain; this resultant cannot be seen, it is, according to all appearances, only the effect of nervous electricity. "There is," says Huschke, "the same relation between thought and the electric vibrations of the cerebral fibres as between colour and the vibration of the ether."

To M. Moleschott belongs the honour of giving a profound *résumé* of this doctrine in the following words: "Thought is a movement of matter."

Such are the principal features of Dr. Büchner's system, and the chief arguments of modern German materialism. It is useless to dwell upon the last chapters of the book *Kraft und Stoff*, chapters which treat of innate ideas, the immortality of the soul, the difference between men and the rest of the animal creation. These chapters are so totally barren of original views, the solutions and ideas they contain are so thoroughly anticipated by all persons in the slightest degree accustomed to these questions, that it would be waste of time to dwell

at any further length upon them. Such as they are, they complete the exposition of the clearest, frankest, and most luminous system of materialism which has appeared in Europe since the famous *Système de la Nature.** The author can assuredly lay claim to no invention, to no originality; but he has brought together elements which were scattered here and there, connected what was incoherent, said aloud what many think, and that, in a book, short, concise, clear, well written. He does us a real service in giving us an adversary to grapple with, instead of those untangible phantoms which, unceasingly hovering between materialism and spiritualism, will not allow us to reach them at any point.

* By Baron d'Holbach.

III.

ON MATTER IN GENERAL.

Every true philosopher, whilst reading the foregoing account of Dr. Büchner's system, has, no doubt, been struck by a strange desideratum it presents: the author, who explains everything by the existence of matter, has completely forgotten to tell us what matter is, what he means by that word. And yet the question is one of some importance; during many centuries it has occupied the attention of men who were neither mad nor childish. Is it not universally known that in the idea of what we call *body* and *matter* are to be found two very different elements: the one arising from our sensations, and which is nothing but the *ensemble* of the various modifications undergone by our organs; the other proceeding from without, really distinct from our impressions, and independent of them? Now those who affirm that matter is the principle of things, evidently allude to matter such as it is, *per se*, and not such as it appears to us; for if analysis were to demonstrate that matter consists merely of our sensations and

that it borrows nothing from without, matter, being nothing else but a modification of our mind, would *ipso facto* disappear, and materialism would become idealism. It is therefore evident that the first condition of a materialist system is to determine what arises from ourselves, and what belongs to external influences in the notion of body or of matter; but the history of science proves that such a determination is extremely difficult. Dr. Büchner has dispensed with it altogether, and therefore the very foundation of his system is defective.

Let us endeavour to do what he has not done—let us show by analysis how obscure and imperfect is the idea of matter, how little it is sufficient for itself, how it vanishes and fades away under examination. "It is," says Fénelon, "a *je ne sais quoi*, which melts within my hands as soon as I press it."

In the first place, we must inquire into what is commonly meant by a body. A body is a solid mass, having the properties of colour, resistance, extension, motion, odour, heat, cold, &c.—in a word, it is an object which strikes my senses; and I am so accustomed to live amongst such objects, to make use of them, to enjoy them, to fear them, to hope for them, that they seem to me the greatest realities in the world; I laugh at those who doubt their existence, and if I wish by my imagination to picture to myself my own mind, I give it the shape of a body. What is the element of truth and of reality in this kind of representation of matter?

In order to answer the question, philosophy begins by distinguishing appearance from reality. This distinction has been made familiar to us by the most exact and most positive sciences. In astronomy, everything rests upon the distinction between real and apparent motion. If we trust to appearances, the sun seems to move from east to west, carrying along with it the planets. Really it is the earth which moves—it has two motions, neither of which we feel, the one of rotation on its own axis, the other of translation round the sun. We must also, when we consider the heavenly bodies, distinguish the apparent from the real magnitude, the apparent from the real situation. In order to have the true altitude of a star in space, astronomers are obliged to take into account the deviation of the rays of light through the atmosphere, that is to say, the phenomenon of refraction. Generally speaking, all the science of optics teaches us not to confound visible appearances with the true form, the true magnitude, the true position, the true movement of objects.

All these facts, and many others equally known, justify us in asking ourselves whether, in the idea which we form of our bodies, there is not a share ascribable to the observer himself, arising from him and disappearing with him. Amongst the qualities which we assign to matter, there are two especially which seem to animate nature, and without which it would appear to us as surrendered over to death —light and sound. Well, let us ask natural

philosophers, what is sound? what is light? Their answer is this: sound and light are vibrations, that is to say, motions. Let us stop for a few minutes to examine that beautiful physical theory which has shed so much light on the question of external perceptions.

If we pinch a chord stretched out, we communicate to it a movement of oscillation which our senses can perceive; by touch we feel it quivering under our finger; our sight, instead of a very clearly marked line, distinguishes a chord swelling about the middle, and much less clear; the swelling goes on diminishing without ceasing, until the chord has returned to a state of repose. This kind of movement is what we call a vibration, and from so elementary a fact has issued the whole vibratory theory, which is of paramount importance in modern natural philosophy, and which is destined to bring about the greatest results. Now, as long as the vibration lasts, as long as the finger feels the chord quiver, we hear a sound. The sound begins and ends with the vibration. Further, the most accurate experiments, the closest calculations establish a rigorous relation between the quality of the sounds produced and the number of vibrations—number which itself corresponds constantly to the length of the chords, the tension, &c. We are, then, justified in affirming that the sole cause of sound is a motion. This motion is communicated by the air, itself a vibrating medium, to the ear, an instrument admirably disposed for the purpose of collecting and

transmitting to the acoustic nerve the aerial vibrations. There, and there only, ceases the mechanical sound, which is replaced by the sensible one. Then it is that the motion is transformed into sensation, a phenomenon yet unexplained, and perhaps baffling all explanation.

What is certain is this: till the moment when the acoustic nerve begins to act, there is nothing out of us but a vibratory movement; so that if we suppose for an instant the hearer disappearing, if we suppose that the nerve capable of receiving the sound is destroyed or paralysed, if we suppose that there is, on earth or in space, no animal capable of hearing, there will be, out of us, nothing, absolutely nothing analagous in the smallest degree to what we call a sound.

Much time, many experiments, many deductions have been required in order to apply to light the theory of vibrations. The sonorous vibrations are perceptible to the senses, the luminous vibrations are not; the elastic medium which transmits sound is perceptible to the senses—it is air; the elastic medium which is considered as transmitting light falls under none of our senses—it is ether. Hence it follows, that, as far as sound is concerned, the vibratory theory is immediately given by experience, and is simply the *résumé* of facts; for light, on the contrary, the vibratory theory is an hypothesis conceived by the mind, and which experience can verify to a greater or a smaller extent: hence the slowness with which this theory has introduced itself, and

the difficulties it has had to encounter. However, it is now definitively admitted by natural philosophers, and here again people have been justified in saying that, considered out of us, out of the feeling subject, out of the eye which sees, light is nothing but a kind of motion. The luminous sensation is a phenomenon peculiar to the living eye, and which can take place only in and through it.

But we shall now state a fact much more extraordinary still, and proving in a decisive manner to what a degree our sensations are subjective, and depending upon our organs; and how much our ideas of matter, such as the senses supply them to us, must be corrected by the mind; this fact is the identity, now admitted by nearly all natural philosophers, of heat and light. From the stand point of sensation, what can there be more different than these two classes of phenomena? They even appear very frequently separated from each other. I may feel heat in darkness, in a mine, for instance, and cold under the influence of a dazzling light. Despite these superficial and seeming oppositions, Melloni's experiments have so multiplied the analogies between the two agents, that science scarcely hesitates to conclude their identity.* Heat, like light, moves in a straight line and with the same rapidity; it is reflected as light is, it is

* Melloni, *De l'Identité des rayons de toutes sortes* (*Bibliothèque universelle de Genève*, 1842). On M. Melloni's works see an interesting sketch by M. Jamin in the *Revue des Deux Mondes* for December 15th, 1854.

refracted according to the same laws, it is transmitted through bodies. Finally, we know that by the addition of two lights obscurity can be produced; well, a striking experiment of Messrs. Fizeaux and Foucault has proved that the combination of two sources of heat can produce cold.* To conclude in the words of a remarkable treatise of natural philosophy recently published: "When we observe a simple ray, we never find a variation of light without a corresponding variation of heat. Such a concordance of results leads to think that warmth and heat are perhaps nothing else but the different manifestations of one and the same radiation; the difference then would result only from the kind of modification of which the object affected is susceptible. On the organ of sight the radiation would give the impression of light; on the organ of touch the impression would be quite otherwise.†"

Out of us, out of the feeling subject, there are not, then, two things, heat and light; there is one thing diversified in our various organs of sensation. Heat is light appreciated by the tactile nerves; light is heat affecting the optic nerve. In the same way as light, according to what we have seen, is nothing but a motion, so heat is nothing but a motion. Thus, to resume the whole of this theory; if we take away the feeling or living sub-

* Verdet, *Théorie Mécanique de la Chaleur*, p. 16.

† *Traité élémentaire de physique*, by Messrs. d'Almeida and Boutan.

ject, the animal, in a word, there is in nature neither heat nor cold, neither light nor darkness, neither noise nor silence; there is nothing but varied motions whose laws and conditions are determined by the science of mechanics.

Physiology supports natural philosophy in demonstrating the subjective character of our sensations. According to Müller, the great German physiologist, the fundamental law of our sensations may be stated thus: "The same cause can produce various sensations in the different kinds of nerves; the most different causes produce the same sensation in each category of nerves."* Thus it is that electricity, brought into contact with each one of our senses, determines in each of them special sensations; in the eye, luminous phenomena, sounds in the ear, tastes in the mouth, ticklings in the tactile nerves. Narcotics likewise produce internal phenomena of hearing and of sight, buzzing in the ear, a dazzling sensation in the eye, itching in the tactile nerves. *Vice versâ*, the luminous sensation is produced in the eye by the vibrations of ether, by mechanical actions, by a shock or a blow, by electricity, by chemical results. It is the same with all our other senses. From these facts, Müller concludes that the senses have each their distinct and defined energies, which are as it were their vital qualities, and he approves that beautiful theory of Aristotle, which, anticipating on all we have pre-

* Müller, *Physiologie*, t. II., l. v., Preliminary remarks.

viously said, describes sensation as the "common act of the feeling and of the felt."*

I am far from wishing to affirm that there is nothing external, nothing objective, as people commonly say, in our perceptions, and that everything resolves itself into the various states of the feeling subject. Nothing is further from my thoughts than such a supposition. Excellent reasons can be given to prove the reality of the external world, the best of which, no doubt, is that we cannot help admitting it. There is accordingly no motive to call in question the reality of external things, and such a doubt will be always frivolous; but, at the same time, it is difficult to determine precisely what is external and what is not; such a difficulty is not frivolous, and upon it hangs all the materialist hypothesis.

In order not to prolong this discussion too much, I suppose the following proposition demonstrated by analysis and by argumentation: "What is external in matter is all that we can conceive as existing independently of the feeling subject, such as extent, movement, impenetrability." Here the difficulties are no longer psychological, they become metaphysical. I shall only name two of the greatest importance: divisibility *ad infinitum*, and the co-existence of force and of extension.

Abandoning on this point the materialist tradition, Dr. Büchner gives up the hypothesis of atoms,

* Aristot. De Animâ III, C. 2, § 4, ἡ δὲ τοῦ αἰσθητοῦ ἐνέργεια καὶ τῆς αἰσθήσεως ἡ αὐτὴ μέν ἐστι καὶ μία.

and admits the *ad infinitum* divisibility of matter; but by so doing, he seems to me to discard all that is positive and clear in the notion of matter. If you accept the *ad infinitum* divisibility, matter vanishes and melts away, nor can you retain for one instant its image. For suppose a compound substance, a heap of sand, for instance; what is there real in that object? Evidently the grains of sand of which it is formed; for the compound itself is something only for my mind, it is only the sum of its parts; if these parts did not exist, it would have no existence. It may strictly be said that the reality which a compound possesses is only that which it owes to its constitutive particles; it is a form which is nothing independently of the matter to which it applies itself. The heap of sand having no reality except that of the grains which constitute it, let us suppose that the grain of sand, in its turn, is a compound body; like the heap itself, it will have only a provisional and relative reality, subordinate to the reality of its constitutive particles. Suppose the same thing for these particles; they will not be, themselves, the reality which we are seeking; and pursuing our enquiry *ad infinitum*, since there is no final term, we shall never arrive at what constitutes the reality of matter. We shall, therefore, say of matter in general, what we say of each compound in particular, that it is only a provisional and relative term subordinate to some absolute condition which we know nothing of.

The same argument can be applied to force as well as to matter, these things being inseparable, according to Messrs. Moleschott and Büchner. If matter is divisible *ad infinitum*, so is force; but, as we said just now, so we repeat, that a compound force has no reality except that of the composing forces from which it results. The force of a team of two horses is only the sum of the forces belonging to both horses. In reality, that which exists is not the resultant considered by the mathematician, but two forces distinct and associated together. If it is so, the general force distributed throughout one piece of matter must be reduced to the elementary forces inherent in the particles of the whole; but, if these particles themselves are compound, the forces adhering to them are compound likewise, and, consequently, are not yet the forces which we are searching. Finally, if every force is divisible *ad infinitum*, we shall never arrive at the last force, that atom of force without which compound force has no reality at all. Then force vanishes away, like matter itself.

Try now to conceive this divisible infinitude (matter and force) as a self-existing absolute, and you will not succeed. What is there, what can there be of absolute in a compound substance? Only its elements; for no one will say, for instance, that such a stone, or such a tree possesses absolute existence. These beings are only the accidental forms produced by the meeting together of various elements. The τὸ πᾶν itself, the Kosmos, is nothing

but the form of forms, the sum of all anterior forms. The absolute necessity of matter can reside therefore only in the elements of matter, and there it is that materialists have always placed it. But if there are no elements, where does the absolute necessity reside? And how could matter be conceived as self-existing? Thus the *ad infinitum* divisibility of matter, if acknowledged as true, should lead the German school to admit a principle different from matter, a principle which, imparting some consistency to this absolute fluidity, would allow it to exist. In a word, a deeper study of the problem will bring back to idealism the new materialist school.

That is not all. Messrs. Moleschott and Büchner have asserted as a self-evident principle the necessary co-existence of matter and force; but if, in bodies, you set aside force from which are derived motion and impenetrability, what remains to constitute matter? Nothing but extension. Matter, then, is a thing having extension and endowed with force. This substance having extension, moves, that is to say, it changes place through space; it is therefore distinguished from the space which contains it. Now, it is precisely here that materialism has always been very much puzzled; for how can we distinguish that extended particle from the particle of space to which it corresponds, and which it fills? Imagination, usurping here the place of reason, certainly represents to us a kind of speck of dust floating in the air. Thus the atoms of Epi-

curus floated through vacuum. But begin by freeing that speck of dust from all that we know of it through the medium of our sight, or of our other senses, reduce it to extension and to force—do not forget that force is a property of matter, and, therefore, of extent, and say to yourself that such an atom, considered in itself, is nothing else but a portion of extent. It has, then, no character by which we can distinguish it from the corresponding portion of space which it is considered as occupying. You cannot say that the force animating it makes the difference, for then you would be asserting that force constitutes matter; matter would then be lost in force, which is the opposite of your system, and the renunciation of the materialist principle. If you admit, on the contrary, matter as essentially extensive, you confound it, like Descartes, with space; and then try and understand motion, figure, diversity, in that full, homogeneous, infinite space!

I have said enough to prove that the new materialist school in Germany has, at its very beginning, given evidence of great ignorance of the questions discussed, when it asserted as a principle the co-existence of force and of matter without giving any definition of either the one or the other, and without showing how they are connected together. The insufficiency of the principle thus shown is to be traced throughout all its consequences. This is what we shall make manifest in the following chapters.

IV.

MATTER AND MOTION.

However unknown the essence of matter may be to us, there is one of its properties nevertheless which we are quite certain of, and which it would be difficult to reconcile with the supposition of a perpetual, self-subsisting matter, having in itself, and in itself alone, the reason of all its determinations: that property is what we call, *inertia*. It is a very long time since thinkers have imagined they could find in inertia the proof of a power superior to matter—of a primary motor. Many philosophers and *savants*, indeed, seem now to consider such an argument as obsolete, and attach to it little importance. I think, however, that a deeper amount of reflection would restore to this proof all its weight.

Let us, in the first place, explain correctly what is meant by *inertia*, and, in doing so, our best course will certainly be to reproduce the definition of Newton, D'Alembert, and Laplace.

Here is the law stated by Newton at the beginning of his *Principia philosophiæ*: "Corpus omne perseverare in statu suo quiescendi vel movendi

uniformiter in directum nisi quatenus a viribus impressis cogitur statum suum mutare."* D'Alembert expresses the same law thus: "A body abandoned to itself must persist eternally in its state of repose or of uniform movement." Finally, Laplace gives a fuller explanation in the following words: "a point at rest cannot give to itself movement, because it has not in itself any reason to move in one direction rather than in another. When it is solicited by any force, and then abandoned to itself, it moves constantly in a uniform manner in the direction of that force; it experiences no resistance, that is to say, its force, and the direction of its movement are the same. This tendency of matter to persevere in a state of movement and of rest is what we call *inertia*. It is the first law of the movement of bodies."† I might multiply the various formulæ which have been given of this law; but the reader is referred to any treatise of mechanics; there is not one which does not contain the principle that a body is incapable of giving to itself movement, and, when it has received it, to stop or suspend it, to change its velocity and its direction.

It seems that after having stated such a principle, the question is immediately solved, for if we begin by laying down as an axiom that any body is incapable of imparting movement to itself, it results that movement can have been communicated to it

* Lex I., p. 12, Amsterdam edition, 1714, 4to.

† Laplace, *Système du Monde*, t. III, chap. 2.

only by a cause distinct from it. Indeed, each body is moved by another, and that other can help us to explain the movement of the former; but that second body, not having been able to impart movement to itself, must have received it from a third which, in like manner, has been acted upon by a fourth, and so on *ad infinitum*. So that if we do not admit outside of the τὸ πᾶν, a motive cause, movement will never have any cause, will always be a causeless phenomenon. That is what Aristotle said. He insisted especially on the impossibility of following the links of the chain *ad infinitum*, and on the necessity of admitting, after all, a primary motor.*

However evident this conclusion may seem at first, it raises, nevertheless, a certain number of difficulties which it is necessary to examine and to discuss, in order that the proof may have all the degree of cogency of which it is capable.

We must acknowledge, to begin with, that it has sometimes been stated in a form which made it liable to objection. For instance, in the *Profession de Foi du Vicaire Savoyard*, Jean Jacques Rousseau expresses himself thus: "As for me, I am so thoroughly convinced that repose is the natural condition of matter, and that in itself it has no power to act, that when I see a body in motion, I immediately conclude that it is an animated body, or one to which movement has been communicated."

* Aristot. Nat. Ausc. VIII, 5, pp. 184, 185, edit. Bekker. Oxon. 1837.

But whence can Rousseau know that repose is the natural state of matter? This is mere prejudice, and the prejudice arises from the fact that we habitually see bodies passing from a state of movement to repose, and that a movement which we have seen beginning always comes to an end. That is why the Scholastic philosophers, before Galileo, believed that matter has a natural tendency to repose, and that movement for it is a violent condition against which it struggles. But Galileo dealt a blow at this prejudice which yet seems to have existed in Euler's time still, since we find it thus stated by him: "It is alleged by the one, that all bodies have a propensity to rest, which is their natural state, and that motion is to them a state of violence; so that when a body is put in motion, it has a tendency, from its very nature, to return to the state of rest; and that it makes every effort to destroy its motion, independently of every external or foreign cause. . . . Do we not see, say they, on the billiard table, that, with whatever force we strike a ball, its motion is quickly slackened, and it returns to a state of rest. As soon as the motion of a clock ceases to be kept up by the external force which set it going, it stops. It is remarked of all machines in general, that this motion lasts no longer than the external powers by which they are agitated." To this opinion Euler answers: "If we attend to everything, we find so many obstacles opposed to motion, that we need no longer wonder it should be so speedily extinguished. In fact, it

is first the friction on the billiard table which diminishes the motion of the ball, for it cannot advance without rubbing against the cloth. Again, the air being a substance, causes likewise a resistance capable of diminishing the motion of bodies. . . . It is evident, then, that in the case of the billiard table, it is the friction and the resistance of the air which counteract the motion of the ball, and soon reduce it to a state of rest. Now, these causes are external, and it is easily comprehensible that, but for these obstacles, the motion of the ball must have always continued."* It is evident, therefore, that bodies have not a natural propensity to repose, and that it is incorrect to say with Jean Jacques Rousseau that rest is the natural state of matter. If it is so, does it not result that the argument of a primary motor, derived from the inertia of matter, is singularly weakened? For this argument still supposes that matter, being naturally in a state of rest, a cause has been required to set it in motion. But since rest is not more natural to matter than motion, why should we not suppose, with equally good reason, matter to have been primitively in motion, as suppose it to have been originally at rest? And if so, it is no longer necessary to suppose a primary motor.

To this difficulty I answer: No doubt it would not be right to suppose matter naturally at rest; but, for the same reason, I cannot suppose it

* Letters to a German Princess. Hunter's translation, London, 1802, Vol. I., pp. 280, 281. Letter 73.

naturally in motion since it remains indifferent between the one and the other. Yet it moves. There must be a sufficient reason to explain this motion. By hypothesis this reason is not in it, it must therefore be without, and, accordingly, there is a principle of motion which is not matter itself.

I go further, and from the principle of inertia I believe we can conclude that matter is only a dependent and derived substance.

Let it be granted for an instant, that matter is self-existent. Is it not clear that it must exist either in a state of rest, or in a state of motion? But neither of these states is essential to it; neither results from its nature, for, if it did, then it would not be true to say that the body is indifferent either to motion or to repose; it would evince a certain propensity for the one rather than for the other. Now phenomena reveal to us nothing of the kind. A body at rest never makes any effort to come out of that state as long as it is not solicited by an external force. There is no reason, then, why matter *per se* should decide between these two conditions. It must, however, decide in order to be, for it cannot remain in an undetermined state; that very state would be one of rest, and then the argument of a primary motor would return with all its cogency. Having, therefore, in itself no reason for choosing between the two conditions, it will not be; and thus it exists only by a cause distinct from it. Such is the con-

sequence which strikes me as resulting rigorously from the principle of inertia united to that of sufficient reason. The argument of a primary motor concluded only to the contingency of motion in matter; the same argument carried on further, concludes to the contingency of matter itself.

And let no one tell us that we are employing here a metaphysical principle—the principle of sufficient reason, and that such principles have nothing to do with the positive sciences: for I contend that, in order to establish the fact of inertia, mathematicians make use of that very argument. What, in fact, does Laplace say? If we suppose a point isolated in space, that point having no reason to go either to the right, or to the left, or in any direction whatsoever, will remain at rest; if the point is in motion, having no reason to alter its direction, it will move in a straight line; finally, if it has a given velocity, it will constantly preserve it, because there is no motive why it should alter it. Thus, whatever aversion scientific men may have for metaphysical principles, they find it impossible to do without them, or else all their own science falls to the ground. It follows then, that, applying the same process of reasoning, we may say: matter being indifferent to repose and to motion, having in itself nothing which inclines it to the one or to the other, and yet not being able to remain in that indeterminate condition (neither rest nor motion) it will not exist, until a different force shall have communicated to it some determination, that is to say, as experience

points out, motion with its direction and its velocity.

All difficulty, however, is not yet eliminated, and here is the objection which awaits us—"You grant," it is said to us, "that matter has no natural tendency to repose. Be it so—that is incontestable. But who tells you that it has not for motion a tendency which requires to be determined by merely one circumstance? Who tells you that motion does not exist in principle in matter itself; that it is not there, as some philosophers say, *in nisu*, in a state of effort or of tendency? And if such a tendency exists in matter, why should we not admit that matter has been eternally in motion? To this new theory Euler answered as follows:—

"The other phalanx is more formidable, for they are no less than the celebrated Wolfian philosophers. They maintain that all bodies, in virtue of their nature, are making continual efforts to change their state; that is, when they are at rest they make an effort to move, and, if they are in motion, make continual efforts to change their velocity and direction. They allege nothing in proof of this assertion, except certain crude reasonings, drawn from their system of metaphysics. . . . I only remark, at present, that this opinion is contradicted by the principle which we have so firmly established (the principle of inertia), and by experience, which is in perfect conformity with it. In fact, if it be true that a body at rest remains, in

virtue of its nature, in that state, it must be undoubtedly false that it should make, in virtue of its nature, continual efforts to change its state. And if it be true that a body in motion preserves, in virtue of its nature, this motion in the same direction and with the same velocity, it is impossible that the same body should, in virtue of its nature, be making continual efforts to change its motion."*

We might be satisfied with the authority of Euler, which, it must be granted, carries considerable weight with it, in a question of mathematical philosophy. But let us try and go a little further. If bodies had a natural tendency to motion, as the scholastic philosophers pretended they had to rest, ought not such a tendency to manifest itself externally by determinate and precise signs? Now, we see clearly indeed that bodies move, which proves that motion is not repugnant to them; but we do not see that of themselves they tend to motion, for whenever motion is produced in a body, we are sure that there is an external cause for it—we always suppose it, and we often ascertain it. Much more, we measure the force which is in the cause by the motion produced, and in that calculation we ascribe absolutely nothing to the body itself; now this could not be understood on the supposition that the body has any share in the motion to which it is subjected, that it co-operates with the external causes to determine the direction and the velocity of that

* Letter 73, pp. 281, 282.

motion. But nothing of the kind occurs—things take place exactly as if the body was absolutely disinterested in its own motion. No doubt we see that, in certain cases, in the fall of bodies, for instance, the velocity increases at every moment, whence it might be concluded that the body's own velocity is added to that which has been communicated to it. But this would be an error. The true cause of that acceleration of motion is in the external cause itself, which, continuing to act at every instant, produces unceasingly a new result, whilst each one of the anterior results persists, by virtue of the law of inertia. Thus our former theory is verified, even in this case, apparently so favourable to the view that motion is an essential quality of matter. In the phenomenon of a shock, each of the bodies struck can determine a motion in the other body, and thus each body can be the cause of motion, but never for itself, and always for any other but itself. If, then, nothing in experience indicates that essential tendency which is supposed, and if things go on exactly as if such a tendency did not exist, all that we can affirm amounts to this: bodies have the capacity of being moved, which is evident; they have likewise the capacity of transmitting motion, and this is not contested; but to affirm that they make an effort to move is to ascribe to them a kind of soul, to destroy the authority of facts, and to introduce an altogether gratuitous hypothesis.

Experience shows to me absolutely nothing but

this: bodies moved by other bodies which are themselves set in motion by others, and so on, *ad infinitum*. Now, if beyond this chain there is not a moving cause, I maintain that we have here a series of movements without cause and without reason. But if I admit for one instant an indefinite series of phenomena without a sufficient reason, I can admit the same thing for each phenomenon in particular; for what is there more in the sum than in a single case? Now, to admit that one single phenomenon can exist without reason and without cause is to upset the whole structure of science.

But that is not the sole view of the question. We shall state now the great objection raised against the argument of a primary motor based upon the inertia of matter. You take, we are told, an abstract, a purely mathematical conception for the expression of reality. The inertia of matter is true in pure mechanics, in geometry; in other words, if we leave out of consideration the forces which animate nature, matter is indifferent both to rest and to motion. But real matter is not that heavy, inactive mass which requires to be set in motion by an external cause. That notion of matter has long since been discarded from science. The analysis of the phenomena of matter is continually discovering to us in it an energetic activity, a kind of vitality. It is evident that matter is perpetually in a state of action, that it has a tendency to action. You must, therefore, introduce those elements of which you take no notice. Will you designate by the name of

inertia the force which animates nature, which Newton has discovered in the planetary system, and which is now applied to the whole universe? But the force of attraction, by which the world imparts motion to itself, is indispensable to matter—it completes and corrects what has been told us about inertia. We want no other God, no other motor than attraction itself.

"I know not in what sense," Diderot remarks, "philosophers have supposed that matter was indifferent to motion and repose. A well-ascertained fact is this: all bodies gravitate the one towards the other; all particles of every body gravitate the one towards the other; everything in this universe is either in translation, or *in nisu*, or in both conditions at the same time. This hypothesis of the philosophers resembles, perhaps, that of geometricians, who admit points without dimensions, lines without breadth or depth, and surfaces without depth. In order to have a representation of motion, you must, they say, imagine, besides existing matter, a force which acts upon it. That is not so. The molecule endowed with a quality peculiar to its nature is *per se* an active force. It exercises itself upon another molecule which reciprocates the action."*

With a view to refute this objection, I shall

* Diderot, *Principes Philosophiques de la Matière et du Mouvement.* In his *De la Métaphysique et de la Science* (Preface p. 17., Second Edition) M. Vacherot admits also this objection. On M. Vacherot see M. Caro's *De l'Idée de Dieu.*

endeavour to establish the three following propositions: 1. Inertia is not an abstraction, but a real universal fact, in no wise contradicted or influenced by attraction; 2. Attraction, understood as an essential force, inherent to matter, is a mere hypothesis, and many endeavours have been made to reduce it to the ordinary laws of motion; 3. If we admit attraction as an efficient property of matter, we do not destroy the character of contingency which we have tried to demonstrate.

Such are the three propositions we wish to prove. It is only with extreme circumspection and, so to say, in trembling, that we venture upon the slippery and difficult ground of high physical science. But our adversaries speak of all these things with so much authority, and such levity at the same time, they are so proud of what they assert, and speak so disdainfully of those who do not think as they do, that we must follow them on that field, acknowledging, which they do not, the difficulty and the rashness of the undertaking.

Inertia, we are told, is an abstraction. I confess that I do not quite understand the meaning of this definition. Does it signify that inertia is one of the properties of matter, but that it is not the only one; that, together with inertia, there are other qualities, attraction, affinity, vital force, &c., and that we make an abstraction when we consider inertia separately from these other properties? I understand the explanation, and agree to it at once. But viewed in the same manner, light is an abstrac-

tion, so is sound, so is electricity; for all these properties are combined together in nature, whilst in science we are obliged to consider them separately. But will it be concluded, therefore, that light, sound, electricity, instead of being real facts, are simply ideal conceptions existing only in our mind? The inference would be completely false. Why should the same affirmation hold good of inertia? It is not only in our mind that bodies are inert, it is in reality. When I construct a machine, I do so on the supposition that the materials I employ are inert; all the movements which take place in nature are subject to the law of inertia; this law is supposed equally by the movements of the heavenly bodies, the most considerable of all, and by the simplest ones. Finally, if inertia is a mere abstraction, I do not know why the same should not be said of all the other properties of matter, and, for instance, of attraction itself; then it will no more be allowed to argue from attraction than from inertia.

The fact of inertia being incontestable, it remains that we ascertain whether it is invalidated by another fact not less true, the fact of attraction.

And here let us ask what is to be understood by attraction. Now this word has two meanings entirely distinct from each other, and the confusion of which throws the mind into a great deal of perplexity and of obscurity. We must endeavour to separate them. The word *attraction* signifies, in the first place, a fact, a fact of experience, an abso-

lutely irrefutable fact, the law of which was demonstrated by Newton. This is the fact: when two bodies, or if you wish, two molecules are in presence of each other, these molecules move towards each other according to the straight line which joins their centres; secondly, if the two bodies are of unequal masses, the smaller moves with the greater rapidity, or in other words, the attraction is in the same proportion as the masses; thirdly, the further a body is, the slower it is in approaching another body supposed to attract it, or, scientifically speaking, the attraction is in inverse ratio of the square of the distances. All these facts are beyond the slightest doubt, and the demonstration of these admirable laws is the greatest discovery made by human genius in the interpretation of nature. But, really, what does experience show? Nothing but reciprocal motion. That is certain, absolutely certain, but nothing else is. It is not the same with attraction considered as a cause, and such is the second meaning attached to the word. Here we must no longer understand motion itself metaphorically expressed, but the hypothetical cause of that motion. Is such a cause in the body or out of it—is it material or spiritual—is it essential to the body, or merely communicated to it? These are questions respecting which natural philosophers may discuss, but which are not to be confounded with the experimental questions definitively solved by observation and calculation combined. Let us then leave for a moment attraction considered as a cause,

and let us view it as an effect, the cause of which is provisionally unknown to us.

We shall see, then, whether attraction, thus understood, that is to say considered as producing the reciprocal fall of molecules one upon another, contradicts in any way the principle of inertia. I say that these two properties, far from contradicting each other, are intimately connected together. In fact, if we can determine exactly the consequences which should result from reciprocal attraction, it is because we suppose the radical impossibility of a body to set itself in motion. How could it be possible to rectify, as has been done with such admirable precision, the perturbations of the planetary bodies, if we suppose for one instant those bodies capable of imparting to themselves changes of motion independent of the law of attraction? Every change of motion supposes an external cause, and astronomers have succeeded in determining *à priori* the existence and position of a perturbating planet, by taking into account all the changes of motion observed in the orbit of Uranus. How could that have been possible, if Uranus had been capable of moving itself and of varying the directions and velocity of its motion? All the discoveries made in the astronomical world suppose, then, inertia;* and there is no contradiction in admitting that a

* "The inertia of matter is chiefly remarkable in the movements of the heavenly bodies, which, for a great number of ages have not experienced any perceptible variations." (Laplace, *Système du Monde*, Vol. III, Chap. 2).

body which moves another, does not move itself, for that is what really takes place. Thus inertia and attraction, far from contradicting each other, on the contrary, support each other reciprocally.

Let us now see if attraction, viewed as a cause of motion, can weaken the consequences which we have deduced from the laws of inertia. It is here that we must make use of the greatest caution, for what do we know of attraction as a cause of motion? Newton himself, on this point, expresses himself with the utmost circumspection. He takes care to warn us several times in his *Principia*, "that he will employ indifferently the words attraction, impulsion, tendency towards a centre; that he considers these various forces, not physically but mathematically, that the reader must take care not to give to those expressions the sense of a determinate mode of action, nor to ascribe to the centres which are mere mathematical points, true forces in the physical sense of the word."* Further on, he tells us that he employs the word attraction in a mathematical sense, "Although considered from the physical point of view those attractions are rather impulsions."† In another passage, he enumerates the various hypotheses which can be made as to the cause of attraction. "Whether," says he, "this motion has for its cause the reciprocal tendency of bodies the one towards the other, or spirits (*spiritus*)

* Amsterdam edition, p. 5.

† *Ibid*, p. 147, *Quamvis fortasse, si physice loquamur verius dicantur impulsus.*

evolved by these bodies and mutually agitating them, or finally the action of an ether or of a subtle air, or of some intermediate principle, material or not, in which the bodies would be plunged, and which would urge them the one towards the other."* He even seems to incline altogether towards this last supposition, and to return to Descartes' *Matière Subtile*, where he says, "It would be perhaps useful to add something, in conclusion, on a very subtle spirit (*spiritu subtilissimo*) which penetrates all bodies and fills their voids. It is by the force and the actions of this spirit that the particles of the different bodies attract each other reciprocally at the smallest distances, and become contiguous: by the same force, bodies having the property of electricity act at greater distances, either in repelling or in attracting neighbouring bodies; it is the cause of the emission of light, of reflection, of refraction, of inflection, and finally of the heat of bodies; by it every sensation is excited, and the action of the limbs determined by the will of the animals, the vibration of that subtle spirit being propagated from the external organs to the brain by the capillary fibres of the nerves, and sent back from the brain to the muscles. But these topics cannot be treated in a few words, and, besides, we have not a sufficient number of experiments to solve them."† While this singular passage betrays all the uncertainty of Newton's thoughts, does it not also show that he was still

* *Principia*, p. 172.
† *Ibid*, p. 484.

much nearer the mechanical philosophy of Decartes than is generally supposed, and that he was much inclined to consider the phenomenon of attraction as the result of an agitation pervading the molecules of an extremely subtle fluid in which he supposed the planetary bodies to be immersed. But the following passage is still more decisive. "It is inconceivable that inanimate brute matter should, without the mediation of something else, which is not material, operate upon and affect other matter without mutual contact, as it must be, if gravitation, in the sense of Epicurus, be essential and inherent in it. And this is one reason why I desired you would not ascribe innate gravity to me. That gravity should be innate, inherent, and essential to matter, so that one body may act upon another at a distance through a vacuum, without the mediation of anything else, by and through which their action and force may be conveyed from one to another, is to me so great an absurdity, that I believe no man, who has in philosophical matters a competent faculty of thinking, can ever fall into it. Gravity must be caused by an agent acting constantly according to certain laws; but whether this agent is material or immaterial, I have left to the consideration of my readers."*

It results from these different texts that in the eyes of Newton (who has certainly some right to command a hearing when the nature of attraction

* Newton's *Third Letter to Dr. Bentley*. See Bentley's works, Dyce's edition. London, 1838, Vol. III, p. 212

is the topic discussed), this phenomenon is probably the effect of a mechanical cause, acting in conformity with the general laws of motion, although we are not provided yet with a sufficient number of experiments to affirm any thing on the nature of that mechanical cause. Some of the greatest *savants* of the eighteenth century have adopted this opinion, Euler, for instance; for whilst defending energetically Newton's law against the Cartesians, he admitted, however, with these, that all the phenomena of motion are mechanically explained, and discarded the idea of an attraction produced at a distance, as an occult quality borrowed from scholasticism. Here is what Euler says on this subject.

"It is established by reasons which cannot be controverted, that an universal gravitation pervades all the heavenly bodies, by which they are attracted towards each other; and that this power is greater in proportion to their proximity. This fact is incontestable; but it has been made a question, whether we ought to give it the name of *attraction* or *impulsion*. The name, undoubtedly, is a matter of indifference; the effect is the same, as your Royal Highness knows, whether a carriage is propelled from behind or drawn forward in front; thus the astronomer, attentive only to the effect of this power, gives himself little trouble to determine whether the heavenly bodies are impelled towards each other, or whether they mutually attract one another: and the person who examines the phenomena only, is unconcerned whether the earth

attracts bodies, or whether they are impelled towards it, by some invisible cause. But, in attempting to dive into the mysteries of nature, it is of importance to know if the heavenly bodies act upon each other by impulsion, or by attraction; if a certain subtle invisible matter impels them towards each other, or if they are endowed with a secret, or occult quality, by which they are mutually attracted. On this question, philosophers are divided: those who are for impulsion call themselves *impulsionists*, and the maintainers of attraction are known as *attractionists*. The late M. Newton inclined very much towards the theory of attraction,* and at the present day all the English are very zealous attractionists. They certainly agree that, in order to attract bodies to itself and to produce the phenomenon of weight, the earth makes use neither of ropes nor of any other of the machines generally employed for traction; still less do they discover between the sun and the earth anything which one might suppose the former makes use of to draw the latter. Supposing we saw a chariot following the horses, although these were not harnessed to it, and supposing we saw neither ropes, nor harness, nor any other thing fit to keep up the communication between the chariot and the horses, we should not say that the chariot was drawn by the horses; much rather should we be

* We have just seen that this is a very exaggerated assertion, and that Newton seemed rather more inclined to adopt the opposite view.

inclined to think that the carriage is propelled by a certain force, although we saw it not, unless it was the trick of some witch; and yet the English will not give up their opinion."*

". . . The English maintain that attraction is a property essential to all the bodies in nature, and that these bodies, hurried along by an irresistible propensity, tend mutually to approach, as if they were impelled by feeling. Other philosophers consider the opinion as absurd, and contrary to the principles of a rational philosophy. They do not deny the fact; they even admit that powers exist, which are the causes of the reciprocal tendency of bodies towards each other; but they maintain, that they are foreign to the bodies; that they belong to the ether, or to the subtle matter which surrounds them, and that bodies may be put in motion by the ether, just as we see that a body, plunged into a fluid, receives several impressions from it. Thus, according to the former, the cause of the attraction resides in the bodies themselves, and is essential to their nature; and, according to the latter, that cause is outside of the bodies, and in the subtle fluid which surrounds them. In this case, the term attraction would be improper, and we must rather say that bodies are impelled towards each other.†

"'. . . The last opinion pleases more those who are fond of clear principles in philosophy, as they do not see how two bodies at a distance can act upon

* Euler's *Letters*.

† *Ibid*, pp. 260, 261. Hunter's *Transl.*

each other, if there be nothing between them. . . Let us suppose, that before the creation of the world, God had created only two bodies, at a distance from each other; that nothing absolutely existed outside of them, and that they were in a state of rest; would it be possible for the one to approach the other, or that they should have a propensity to approach? How could the one feel the other at a distance? Whence could arise the desire of approaching? These are questions from which we recoil; but if you suppose that the intermediate space is filled with a subtle matter, we can comprehend at once that this matter may act upon the bodies, by impelling them; the effect would be the same as if they possessed a power of mutual attraction.* Now, as we know that the whole space which separates the heavenly bodies is filled with a subtle matter called *ether*, it seems more reasonable to ascribe the mutual attraction of bodies to an action which the ether exercises upon them, though its manner of acting may be unknown to us, rather than to have recourse to an unintelligible property. . .'' . We ought, therefore, to consider attraction as an occult quality, in as far as it is given for a

* To this affirmation Voltaire, d'Alembert, and the whole attractionist school opposed the following objection: attraction is proportional to the mass, that is to say, to the quantity of matter, whilst the impulse is only proportional to the quantity of surface. This objection would be sound if it applied to a fluid exerting its action merely on the surface. But if it penetrates in the interior of the body, and fills all the interstices, who can affirm that the law of impulse is not observed?

property essential to matter; but as the idea of all occult qualities is now banished from philosophy, attraction, considered in this sense, ought to be banished likewise."*

Several attempts have been made by illustrious philosophers to solve scientifically the problem stated by Euler, viz: the reduction of attraction to impulsion. M. Arago, in his biographical notice on Laplace, gives us an account of one of these attempts, and does not seem far from inclining to it himself.

"The accusation of occult quality directed against the theory of universal attraction led Newton and his most fervent disciples out of the reserve which they had thought fit to maintain. People consigned to the class of ignoramuses those who considered attraction as an essential property of matter, and as the mysterious indication of a kind of charm, and who supposed that two bodies can act upon each other without the interposition of a third body. Newton never explained himself clearly respecting the manner in which an impulsion can arise, physical cause of the attractive power of matter, at least, in our solar system; but we have at the present time strong reasons to suppose that in writing the word *impulsion*, the great geometrician had in his mind the systematic ideas of Varignon and of Fatio de Duillier, afterwards rediscovered and perfected by Lesage; these ideas, in fact, had been communicated to him before they were published."

* Euler's *Letters*, pp. 262, 263.

"According to the views of Lesage,* there are, in the regions of space, corpuscules moving in every possible direction, and with excessive rapidity. The author gave to these corpuscules the name of ultra-mundane. Their *ensemble* composed the gravific fluid, if, however, the designation fluid may be applied to a collection of particles having no connection together. One body placed in the midst of such an ocean of moving corpuscules would remain in a state of repose, being equally moved in every direction. On the contrary, two bodies ought to move the one towards the other; they would act mutually as a screen the one for the other, because their corresponding surfaces would no longer be struck by the ultra-mundane corpuscules in the direction of the connecting line, for then currents would exist, having an effect no longer destroyed by contrary currents. We see, besides, that two bodies plunged into the gravific fluid would tend to draw near one another with an intensity varying in inverse ratio of the square of the distances."

Amongst the philosophers who have hesitated to consider attraction as essential matter, we must also name M. Biot.

"According to the principles of a sound science," this eminent *savant* remarks, "the qualities of

* Lesage, George Louis (1676-1759), distinguished as a naturalist and a philosopher. See Haag's *France Protestante*, Part 12. Fatio de Duillier, like Lesage, was a Swiss philosopher—Varignon, Pierre (1654-1722). His *Projet d'une Nouvelle Mécanique*, published in 1682, is still considered a most remarkable work.

material bodies which we can call universal, seem limited to those, the combination of which is necessary to bring them under our knowledge, and to characterise them essentially, conformably with the idea which our mind forms of them; such are extension and impenetrability, to which we add mobility and inertia. This last expression designates the want of spontaneity, in consequence of which matter, viewed in its own essence, is indifferent to the states of motion and of repose. Thus observed, the gravitation, proportional to the masses, and reciprocal to the squares of the distances, which is exercised between the material elements of all the planetary bodies, is not a quality which we can call universal, because we might conceive the existence of material bodies deprived of it, or gravitating one upon another according to other laws. Stars are now known which move around other stars in convex orbits. Is the force which produces these orbits identical with our planetary gravitation, or different from it? It is impossible to decide *à priori*, and endeavours are made to determine the alternative by ascertaining the phenomenal laws of the movements thus realised.* But supposing the identity was proved, it would still be impossible to affirm that this gravitation is a quality peculiar to matter; for it might be merely a contingent effect resulting from mechanical causes acting upon it, and foreign to its essence; and Newton himself at a later period

* It is admitted now that the law of gravitation is verified in the case alluded to by M. Biot. This is what is called *Stellar Gravitation.*

showed that it would not be impossible to imagine some such. Then it would be necessary to seek for the cause of these causes, and so on, in following a chain the extremity of which is concealed in infinitude."

By the imposing testimonies we have just adduced, and by others besides: Euler (we might add Maupertuis, who states his opinion on that point), Lesage, Biot, Arago to a certain extent, and finally Newton himself;—by these testimonies, we say, it will be seen that a mechanical explanation of attraction has never been, and is not yet, at the present day, considered as impossible. Further, whatever may have been affirmed to the contrary, it is not at all exact to say that the mechanical theories of Descartes and of his school have been invalidated by the progress of modern science. On the contrary, modern science seems more and more every day moving in the mechanical direction, and endeavouring to reduce all the properties of matter to figure and to motion. What can there be more remarkable, thus viewed, than the mechanical theory of heat, the vibratory theory of light? In chemistry, the theory of isomerism,* the theory of molecular dissymetry, &c. ?† Thus, figure and mo-

* In chemistry, the name of *isomerous* is given to substances composed of the same elements, in the same proportion, and whose respective properties are radically different, by virtue of the difference of grouping.

† See the beautiful researches of M. Pasteur. Two substances are called *dissymetrical*, when they are absolutely similar in all respects, except that they are opposed to each other like the two hands in the human body. From this diversity alone very different properties arise.

tion, the two only things which our mind conceives clearly and distinctly as belonging to matter, are the principles to which natural philosophy and chemistry seem to lead on all sides. Why should not attraction itself be reduced to a mechanical cause, why should it be anything else but a particular phenomenon of motion, the determining causes of which are not a whit less material causes, although they are unapplicable by our senses? If we think especially of the ever-growing importance which the hypothesis of ether assumes in modern science (the ether does not seem very different from Descartes' *matière subtile*) we ask why ether, which is the cause of light, of heat, of electricity, should not also be the cause of attraction?

If it was thus, if attraction could one day be mechanically explained, the movements of attraction would be accounted for by the general laws of motion. We are not justified, then, in opposing attraction to inertia, and in considering the former as a real property, essential to matter, and the latter as a mere mathematical abstraction. We can, on the contrary, affirm inertia to be a real property, essential to matter, and which facts will never invalidate; whilst attraction (considered as a real cause) may disappear before the investigations of a deeper science, and reduce itself to properties already known.

We have one last question to examine. In supposing attraction to be one of the elementary and irreductible properties of matter, would it be necessary to conclude that matter has in itself the

cause of its motion? And would inertia, in this hypothesis, be of any use to prove the necessity of an immaterial motor? That is the obscurest and most difficult point of the debate in which we are engaged.

Here is the hypothesis at which we must place ourselves: Two molecules of matter, which, considered separately and each one in itself, are indifferent to motion and to repose, become to one another, as soon as they are in presence of one another, reciprocal causes of motion; in other terms, a body which cannot move itself, is capable of moving another one, and of being moved by it. Now, that is already true, even in the hypothesis of impulsion; but there is this difference, that in the last-named hypothesis, each body which moves another one, is in its turn moved by a third, and this by a fourth, and so on *ad infinitum;* so that all the motions which take place in nature form a chain out of which we are obliged to seek the true cause of the total motion. On the contrary, in attraction, there is no infinite chain. Two molecules suffice to be to each other the cause of motion. We are thus as near essential motion as possible; only, instead of one molecule, we require two. They move one another without our being obliged to have recourse to a third term; and, in considering the universe as an *ensemble* of molecules moving by attraction, these reciprocal attractions seem to concentrate the cause of motion in the universe itself. Here all the motions appear coordinate to one central prin-

ciple, and instead of imagining the universe as a chain which has neither beginning nor end, we ought to view it, according to the old simile of Empedocles revived by Pascal, as an infinite circle of which the centre is everywhere and the circumference nowhere.

Now, it seems to me that from this hypothesis an evident consequence results, which is this: matter is not an absolute thing, but a relative one, not having in itself its reason of existing. For each molecule is connected with all the other molecules in the Universe, and these are all reciprocally connected together by reciprocal attractions; so that each molecule, considered separately, has not in itself the reason of its determination, that is to say, of its motion. This reason is out of it in the other molecules, and the same proposition is true of all the other molecules, without exception. We cannot then say of each molecule, taken separately, that it is an absolute, self-sufficient thing; for, if it was so, it ought to have in itself, and in itself alone, the reason of its motion. What is true of each molecule is true of all; being all solidary, they have, separately, no absolute existence. But, it will be objected, it is not the parts which possess this absolute existence, it is the whole. I answer that, if the whole is nothing else but the collection of the parts, it cannot possess a quality which these have not separately; a sum of relative parts cannot form an absolute whole.

If I am told that the molecule itself is not the last

element of matter, that beyond the molecule there is something else, and that it is this something which is absolute, I answer that such a supposition is very possible, and that I am not now disputing it; but then the objector abandons what I call materialism in order to adopt another hypothesis, which has nothing to do with the present discussion. The molecule is the last possible and imaginable representation of matter; beyond it there is something else, which is no longer matter, but another principle conceivable only by the mind; call it idea, substance, force, whatever you please, but not matter. Matter is what I know through the medium of my senses; that which is beyond, which my senses and my immediate experience give me no knowledge of, is not matter.

In what I call a body, I can, indeed, resolve certain qualities into certain others, secondary qualities into primary ones, odour, taste, colour into figure and motion; but as long as something remains of what I have appreciated, the body remains; and when I say that everything is body and matter, I mean that everything reduces itself to elements more or less similar to those which my senses perceive. But if, in my sensible perceptions, everything is phenomenal, there are nothing but appearances; if the substratum of the sensible thing is absolutely different from that thing itself, I say that that sensible thing which I call matter, is only relative, and reductible to a superior principle the power and dignity of which I can no longer measure

by my senses. Matter, then, vanishes into a principle superior to it, and materialism abdicates before idealism. What, I ask, would be the pretensions of materialism in a system, the maintainers of which would be obliged to confess that matter reduces itself to a principle absolutely unknown? According to such an hypothesis, to say that matter is the principle of all things, would it not be the same as to say: "*x*, viz: some unknown quantity, is the principle of all things?" Or, in other words: "I do not know what is the principle of things,"—a very luminous materialism indeed.

V.

MATTER AND LIFE.

If materialism does not explain matter itself, much less does it account for the two greatest mysteries which nature presents—life and thought.

Is life a property of matter or, at least, the result of certain properties of matter in certain given conditions ? or else, is it the effect of some cause distinct from matter, of a principle which we shall call immaterial if not spiritual, spirituality being reserved to the thinking soul, as its essential and privileged attribute ? Such is the great debate which divides at the present time scientific men and metaphysicians, and which has given rise to a large number of systems. Without attempting the expositions of these various systems, let us insist upon the principal facts which still maintain an indestructible separation between brute matter and living matter.

The first and most important of these facts is the harmonious unity of the living and organised being : it is, in order to employ Kant's expression, "the correlation of the parts to the whole." "The or-

ganised bodies," says the great physiologist, Muller, "do not only differ from the unorganised bodies by the manner in which their constitutive elements are arranged; the continual activity displayed in living organised matter enjoys also a creative power submitted to the laws of a reasoned plan, of harmony; for the parts are so disposed that they correspond to the end in view of which the whole exists; and that is precisely the characteristic feature of organism. Kant says that the cause of the modes of existence in each part of a living body is contained in the whole; whilst in dead masses, each part carries it in itself.* Kant expresses also the same idea, when he says that in the organised being everything is reciprocally cause and effect, end and means: thus, for instance, the tree produces the leaf which, in its turn, protects the tree, and contributes to its nourishment and preservation.

This metaphysical definition of the living being is quite in accordance with that of Cuvier: "Every organised being," says the great naturalist, "forms an *ensemble*, a separate system, of which all the parts mutually correspond and concur to the same final actions by reciprocal reaction." Cuvier applies this definition to the organisation of carnivorous animals. "If the intestines of an animal," he says, "are organised so as to digest flesh—the flesh of another animal recently killed, his jaws must also be constructed so as to devour a prey; his claws to seize and tear it; his teeth to cut and divide it; the

* Müller, *Prolégomènes.*

entire system of his organs of locomotion to pursue and reach it, his senses to perceive it from a distance, it is even necessary that nature should have placed in his brain the instinct requisite to make him know how to conceal himself and lay snares for his victim. Such are the general conditions of the carnivorous *régime*, every animal destined for this *régime* will infallibly possess them; for, without them, his race could not have subsisted.* It is this law which has been called the law of *organic correlations;* it is exclusively adapted to organised beings.

This first character of the living being is too well known to require any further development; we shall, besides, understand it better by examining the difficulties it can raise, and which can be reduced to two principal ones. The former is that, in certain cases, the unorganised beings themselves seem to present a character similar to the one we have just noticed, and to constitute harmonious *ensembles* in which there is a correlation of the parts to the general form of the whole. That is what takes place in crystallisations; when a body passes from the liquid to the solid state, it then assumes regular and geometrical shapes; even each species of bodies has its distinct type, always the same, which allows us to recognize and to define it. Thus, there are species of crystal as there are living species; and in each one of them the molecules arrange and group themselves as if they acted in accordance

* Cuvier, *Discours sur les Révolutions du Globe.*

with a pre-existing plan or type. The second difficulty is that the living beings, on their side, do not always present, as it seems, the character of absolute correlation between the various parts, which we have mentioned. The proof of this is that there are certain beings which can be cut and divided like unorganised bodies, and the fragments of which re-form themselves in accordance with the original whole. There is not, then, in all living beings, so absolute a solidarity of the parts and of the whole as Kant and Cuvier make out.

With respect to the former of these difficulties, I answer that we must carefully distinguish the geometrical regularity which crystals present, from the harmonious action which is the distinctive sign of organised beings. The geometrical form, is so to say, only an *extrinsic* disposition, a juxtaposition of parts, which considered from without, indeed constitute a whole; but which, really, are independent from one another. The various surfaces, the various angles presented by a crystal have no reciprocal action and influence; as Müller has said, "There is in the crystal no relation between its configuration and the activity of the whole." It is quite otherwise in animated beings; there is action and reaction of the parts on each other, there are mutual services, there is a common action. Thus the heart is indispensable to the lungs, the lungs to the heart, and all the parts act in common to produce the general phenomenon of life. We must, therefore, not confound organised with geometrical harmony.

It is very true that there are in organised beings certain relations of symmetry which can be compared, if you please, to the symmetry of crystals. Thus M. Dutrochet makes us notice that the two principal types met with in the vegetable and the animal organisation, the radiated type (radiata) and the branch-like type (vertebrata) are to be found in certain crystals, for instance, in the star-shaped snow flake.* But this geometrical symmetry is entirely distinct from the correlation of organs described by Cuvier as the fundamental law of the organised and living being.

With reference to the organised beings, both animals and plants, which are reproduced by fissiparity and by cuttings, I shall remind my readers that there is nothing there that can be compared to unorganised beings. For in these, in a broken stone, for instance, the pieces remain such as they are, and are endowed with no power of reparation and of reproduction: on the contrary, in cases of fissiparity, each part reproduces the whole animal. There is, then, so to say, in each part a power representative of the whole, and which, if separated, will immediately become realised. Now, nothing similar exists in chemical crystallisations; each part will not reproduce the whole.

The second character of the living being is its mode of increase. It is generally said that the distinguishing feature between the organised being and

* Dutrochet, *Mémoire sur les Végétaux et les Animaux*, 1857, Avant-propos, p. xxiii.

the unorganised one, is that the latter is developed by *juxtaposition*, and the former by *intussusception*; that is to say, in the latter the increase takes place from without, and in the former from within. That character has been contested by several naturalists and philosophers opposed to the vital principle, that is to say, disinclined to admit a principle of life distinct from the general forces of nature. Dutrochet, for instance, has remarked that the internal increase always ends by being a juxtaposition.* Since it is necessary that the molecules introduced should place themselves close to those already existing, a moment arrives when the new molecules are in juxtaposition with the preceding ones. *Vice versâ*, in unorganised beings we sometimes notice an intercallary mode of development. Thus, in porous minerals, liquids introduce themselves into the pores, where they may become solidified, and then form one mass with the primitive mineral. Such an intercallary scheme of growth is similar to intussusception.

There is, if I am not mistaken, a great difference between these two facts. In the organised beings the molecules, on entering, do not find cavities ready made for them. Evidently the new molecules must displace the preceding ones in such a manner that the tissues become successively enlarged. It is not the same in minerals. There the molecules can enter only into ready made cavities, and the mineral remains what it was. Of course portions of

* Dutrochet, *Mémoire sur les Végétaux*, Preface, p. xix.

matter can occupy these cavities, but this resembles in nothing the internal assimilation of our tissues, that intimate fusion which constitutes nutrition. There is, besides, a still deeper difference between the development of living bodies and that of unorganised beings, viz., in a living being the new molecules arrive only because others disappear. There is a perpetual exchange between the molecules of within and the molecules of without. That is what is called the *tourbillon vital.* The experiments of M. Flourens on the bones have illustrated this fact in a very striking manner; for if the bones, solid substances, sometimes assimilated to dead masses, are continually renewed, *à fortiori* must the case be the same in the soft and liquid parts of the animal. "In the most hidden depths of living beings there reign two contrary currents, the one taking away constantly, molecule after molecule, something from the organism; the other repairing, in the same proportion, the breaches which would produce death if allowed to be too multiplied."* Now, from this fundamental fact result consequences which widen still more the differences between the mineral kingdom and the living one: these are the correlative and alternative increase and decrease in living individuals. The living being increases up to a given period, then decreases, weakens, perishes away, and finally dies. Now nothing similar takes place in unorganised beings.

* Quatrefages, *Métamorphose de l'Homme et des Animaux.* Chap. I.

You will not find there the increase limited to a given time, to a given shape, to a given size, then necessarily followed by successive decrease, and finally by dissolution. Suppose the living being subjected merely to the laws of natural philosophy and of chemistry, how do you account for that successive decay which is called old age, caducity, and which always ends in death? I admit very well that the organised being can perish accidentally, that an external force can destroy him, as it can destroy rocks. But how can a living being fall into decay spontaneously, so to say, and with rigorously fixed limits of time? That can scarcely be explained from the stand-point of a purely materialist hypothesis of life. If the living being did not exchange its molecules for fresh ones, it might be said that these molecules are worn out by friction, and that a moment comes when they are incapable of acting, just as the worn-out springs of a machine. But in a being which is constantly renewing its materials, there is no reason why this combination, this internal chemical or physical movement should not last for ever, by virtue of the laws of matter. That internal force exhausting itself, notwithstanding the renewal of materials, is a fact which physico-chemical explanations cannot account for.

In a curious preface, where he criticises energetically the vital principle, Dutrochet says that life is nothing but a temporary exception to the general laws of matter, a temporary and accidental suspen-

sion of the physical and chemical laws which always end by triumphing, and their triumph is what we call death. Dutrochet's theory might be conceived if life was, indeed, a mere accident, and if we saw a living being appearing or disappearing here and there, as for instance, monsters in the organic kingdom. But it is not true that life is an exception. It is a phenomenon as general as any of those which inanimate matter presents. Besides, the triumph of death over life is not absolute. The individual dies, the species subsists; or if certain species disappear, others succeed to them. Life maintains, therefore, its equilibrium with the external causes of destruction which threaten it; only a general and permanent cause can explain so permanent a phenomenon.

Some physiologists, very decided adversaries of the mechanical, physical, and chemical explanations of vital phenomena, and very strong upholders of vital properties, do not, however, admit that, for this reason, life should be considered as the effect of an immaterial cause. For why, they say, cannot matter have vital properties distinct from chemical properties, just as these are distinct from physical ones? Thus vitalism would not necessarily exclude materialism. But these *savants* do not seem to me to understand clearly their own opinion.

For, if we saw that all matter is endowed with vital properties, we might suppose that these properties are inherent to it just as physical or chemical ones. But as we see only a certain number of bodies

endowed with life, it is evident that life would be not an essential property of matter, but the result of a certain special condition of matter; in other terms, the result of a certain grouping of molecules, of a certain concurrence of affinities, and thus you are evidently taken back to physico-chemical explanations. Another hypothesis, indeed, might be adduced; it might be said that there are two sorts of matter, the inanimate and the animate, each having its different properties. Such was the doctrine of Buffon, whose supposition of the organised molecules was very celebrated during the eighteenth century. According to him, the molecules are naturally animate, that is to say endowed with sensibility and with irritability; they unceasingly pass on from one living body to another—there is a perpetual exchange of these molecules between all living beings; but these molecules do not form part of unorganised beings, and unorganised molecules only enter accessorily into the composition of living bodies. That hypothesis, however, is completely upset now by the recent progress of organic chemistry; it is demonstrated that the matter of living bodies is the same as that of unorganised ones, and that the elements of living matter are reductible to oxygen, hydrogen, azote, and carbon, to which are added other elements, as phosphorus, iron, sulphur, &c.

From the two facts combined—1st, That all bodies are not endowed with life: 2nd, That living bodies are composed of the same materials as the other

ones, it results evidently that life, if it is a property of matter, is certainly not a primitive and irreductible one; but a special condition, arising from the grouping of certain elements arranged according to determined properties. Now, that is precisely the argument maintained by the opponents of vital properties. It is impossible, therefore, to defend at the same time, consistently, vitalism and materialism; unless, however, the words *life*, or *vital force* are merely considered as conventional terms, meant to represent a group of phenomena provisionally independent of all other groups, and to this the staunchest materialists will readily agree.

The true discussion, then, is between those who think that the vital phenomena may one day be explained by the laws of natural philosophy and of chemistry—that is to say, by the general laws of matter viewed in certain special applications; and those who, seeing that inanimate matter and life are so completely, so radically different from each other, consider the reduction of life to matter as a gratuitous hypothesis belied by the most striking facts.

We must, nevertheless, acknowledge that since Descartes, the explanation of vital phenomena by the general laws of matter has made, and is still making every day, fresh progress. For, since Lavoisier, the fact of breathing has been reduced to the altogether chemical phenomenon of combustion. The experiments on artificial digestion, inaugurated by Spallanzani, and developed since by so many eminent physiologists, tend equally to prove that

digestion is only a chemical phenomenon.* The discovery of endosmosis by Dutrochet has shown a similarity between the facts of absorption and those of capillarity, whilst Mr. Graham's recent investigations have cast a great deal of light upon secretions. Electricity does not explain all the phenomena of life, as was supposed during the first excitement caused by Galvani's discovery; at the same time, it is one of the principal agents of organised bodies, and enters certainly for a great deal in the theory of motion. The mechanical theory of heat has, perhaps, carried further than any other scheme the possibility of a physical explanation of life. Could not the capital fact of life be identified with the transformation of heat into motion—a phenomenon which we can observe in our machines, and the laws of which are rigorously known? Finally, long before all these discoveries, and in the very age of Descartes, the school of Borelli had applied the theories of mechanics to the motion of living bodies. From these various facts, it results indeed that a very large number of vital phenomena can even now be explained by the laws of natural philosophy and of chemistry; and as for those which still resist, have we no reason to believe that one day we shall likewise account for them in the same manner?

Without ignoring the striking results apparent in this steady progress of science, it seems to me, nevertheless, that we must distinguish here two things—the phenomena taking place in the living

* See Müller, Vol. I., Book II., Sect. IV., Chap. V.

being, and the living being himself. I do not deny that the phenomena of life are submitted, in a certain degree, to the laws of natural philosophy and of chemistry; but it does not follow that life itself is a mechanical, physical, or chemical phenomenon, for it still remains to be known how all these phenomena combine together to form a living being. There is still, then, a central unity co-ordinating all these phenomena towards the production of one central act. There is the great law of birth and death, to which the purely physical world offers no analogy. Finally, there is that other law of reproduction which, still more than the preceding one, marks out between the two kingdoms a barrier up to the present time impassable. Thus it is especially in the wonderful fact of generation that the most decided materialists find, and will for a long time still find themselves checked.

VI.

ON SPONTANEOUS GENERATION.

THE problem of the origin of life on the terrestrial globe is one of the obscurest in human science, and before it cautious philosophers will always prefer keeping silence than proposing hypotheses, the verification of which is so difficult. If there is a truth demonstrated in geology, it is this: life has not always existed on our earth; it has appeared there on a given day, no doubt under its most elementary form; for every thing leads us to believe that nature, in its development, follows the law of gradation and of progress; but, after all, on one given day, life has appeared. How? where did it come? By virtue of what miracle did brute matter become living and animated? That, I repeat, is a great mystery, and every wise man will prefer holding his tongue to affirming what he does not know.

For Dr. Büchner, however, there is no difficulty whatever here. Life is a certain combination of matter, which became possible as soon as matter was placed in favourable circumstances. If he limited himself to this statement, it would be hard

to refute him; for who can know what is possible, and what is not? But the German author goes much further. In his opinion, nature has never witnessed the appearance of a new force. All that has been produced during past ages, must have been the result of forces similar to those with which we are acquainted at the present day. He thereby pledges himself to maintain that even to-day we are witnessing the miracle of the origin of life, and that matter is adapted to the spontaneous production of living organisms. By placing discussion on this new ground, he gives to it a solid basis, for we can now ask what science teaches us respecting the present origin of living beings; in a word, what is now the state of science respecting the old and famous problem of spontaneous generation.*

We call spontaneous generation, or *heterogenesis*, the formation of certain living beings, without pre-existing germs, by the mere play of the physical and chemical forces of matter. In the remotest antiquity a belief in spontaneous generation prevailed. "We may see, in fact, living worms," says Lucretius, "spring out of stinking dung when the soaked earth has gotten putridity after excessive rains."† The elements, set in motion and brought together under new conditions, give birth to animals." This

* For an interesting *résumé* of the discussion on spontaneous generation, the reader is referred to the Lectures of M. Milne Edwards, reproduced in the *Revue des Cours Publics Scientifiques*, Dec. 5th, 12th, 19th, 1863.

† Quippe videre licet, vivos exsistere vermeis
Stercore de tetro, putorem quom sibi nacta est,
Intempestivis ex imbribus humida tellus.—*Lib. II.*

belief was still prevalent during the sixteenth and seventeenth centuries. Van Helmont describes the means of producing mice; other authors have given a recipe for the creation of frogs and of eels. A decisive experiment made by Redi struck a fatal blow at all these ridiculous superstitions. He showed that the worms to be found in meat are nothing but the larvæ of the eggs of flies, and that by surrounding meat with gauze, the birth of these larvæ was prevented; the eggs deposited on the gauze were subsequently examined, and the mystery discovered. The introduction of the microscope opened, however, a new field to the maintainers of spontaneous generation. The microscopic animals which appear in the infusions of animal and vegetable matter seemed to be produced out of all sexual conditions, and without pre-existing germs. The fine experiments of Needham apparently told in favour of that opinion; those of Spallanzani, on the contrary, impugned it, although they did not definitively conquer it. Towards the beginning of the present century a capital experiment of Schwann advanced the question very positively, but in a direction opposed to spontaneous generation. Science seemed to have given up the problem, when M. Pouchet rendered it once more fashionable by experiments which created some noise, and which, according to him, completely proved the fact of generation independent of germs. The anti-vitalists triumphed, when another *savant*, one of the most eminent chemists, M. Pasteur, took up the question and carried it as far, or nearly as

far as it can be carried just now. With the help of the most delicate, the most ingenious, and the most solid experiments, he refuted all the arguments of heterogenists; and I think I may say that, in this important discussion, the *Académie des Sciences* and the great majority of scientific men have been on his side.

It would be difficult for us to enter here into the detail of the experimental discussions which have taken place. Let it suffice to give a general and philosophical idea of the question. Thus, it is already a remarkable fact and a presumption unfavourable to spontaneous generation, that the advocates of that hypothesis should have been by degrees driven back to the domains of the infinitely small, to the sphere of the invisible, if we may say so—a sphere where experiments are so difficult, where the eye is so easily deceived. If such a mode of generation were possible, we do not see why it could not take place in other parts of the animal kingdom, and why it should be precisely reduced to the microscopic world.

Dr. Büchner, indeed, tells us that amongst the animalculæ are to be found the most imperfect organisms, and that, consequently, we understand their being produced by the simplest and most elementary mode of generation; but then, we may ask in return, if the perfection of organisms is precisely in the same ratio as their dimensions, and if the smallest are uniformly the most imperfect? Now, this evidently is not the case. If we admit, together with M.

Milne Edwards, that the perfection of an animal is in the same ratio as what he calls the *division of labour*, that is to say, the division of the organs and of the functions, it is easy to perceive that such a division has nothing whatever to do with the size of the animal. Thus the insects, for example, which are generally very small, are animals greatly superior to the molluscs by the number and division of the functions, and yet they are inferior to them by their dimensions. Man, the most perfect of animals, is not the largest. We cannot conclude, then, from smallness to imperfection, and, consequently, the pretended imperfection of infusoria does not explain why spontaneous generation should occur only in the world of the infinitely small. I add that the organisation of the infusoria is by no means, as some persons might be led to assume, a simple organisation. It is, on the contrary, a very complex one, and the illustrious micrographer, Ehrenberg, has demonstrated that these little animals, almost invisible, are as perfect and as fully organised as many animals of a higher class.* Dr. Büchner himself tells us that the rotifer, which is not larger than one-twentieth of a line, has a mouth, teeth, a stomach, intestinal glandulæ, vessels and nerves.

People, moreover, adduce in favour of spontaneous generation the following argument: "If there was," they say, "only one mode of generation, the sexual one, one might understand our being disposed to reject as a mere illusion, contrary to the universal

* Ehrenberg, *Organisation der Infusions Thierchen.*

law, spontaneous productions, in certain cases; but experience tells us that there are very varied modes of generation; why should not one of these modes, at the lowest scale of animality, be heterogenesis?"

This objection is important enough to stop us for a few moments.

The curious experiments of C. Bonnet (of Geneva)* on aphides, those of Trembley† on the water hydræ, those of many other naturalists on the other classes of polyps, and, generally speaking, on inferior animals, have apprised us that there are for animals as well as for plants, three principal and distinct modes of reproduction, sexual reproduction, gemmiparity or reproduction by buds, and fissiparity, or reproduction by cuttings, by scission, by division. These three modes can even be subdivided, and there are intermediate shades. Thus, the sexes can be separate or united; when they are united in the same individual, we have hermaphroditism. It may further happen that there is only one sex, the female, which reproduces itself without the concurrence of the male element; that is what is called parthenogenesis. On the other hand, gemmiparity, or reproduction by buds, may be internal or external; the bud may drop inside the animal and develope itself in him so as to come from him completely formed, and thus to imitate ordinary reproduction; or else the bud may drop outside and develope

* Charles Bonnet (1720-1793) celebrated as a naturalist and a philosopher. See on him Messrs Haag's *La France Protestante.*

† Abraham Trembley (1710-1782). Messrs. Haag have also devoted an article to him, *ubi supra.*

itself in an external medium. Finally, fissiparity itself includes various subdivisions; it is spontaneous or artificial; spontaneous, when the animal of its own accord divides itself into two distinct animals; artificial, when an external division produces multiplication.*

Between this last mode, fissiparity, and what we call spontaneous generation, is there then so great a difference, and could not nature pass from the one to the other? Could not the scale of the development of life be represented in the following manner? The first degree of life, at its appearance, would be spontaneous; a simple combination of matter might determine its existence. Then, the living being once born, would reproduce itself by simple scission; at a higher degree, by budding, first external, then internal; higher still, the female sex would appear, bringing forth eggs capable of being fruitful without the concurrence of the male; higher still, we might have the male element, but united in the same individual with the female one; finally, at the highest point of the scale, the sexes would be separated into two distinct individuals; and here again a difference would exist between oviparous and viviparous animals. Thus the sexes would be only the last degree of a series of modes of generation, the first of which is only a chemical combination, a mere material aggregation.†

* Examples of all these varied modes of generation will be found in the curious book of M. de Quatrefages on the *Metamorphoses of Man and of Animals.*

† It is thus that M. de Lamarck accounts for the origin of the sexes.

Suppose now, with M. de Lamarck and other naturalists, that living forms are susceptible of being modified *ad infinitum*, and that the different animal or vegetable species are only the successive transformations of one and the same type, one same animal, one same plant, we can understand that the sexes may thus have been produced by a series of gradual transformations, beginning with spontaneous generation, and rising to viviparous production, the most perfect of all.

Leaving aside this last point of the question, viz.: the transformation of animal species—a capital problem which we shall allude to in one of the subsequent chapters, let us see what we must think of that gradual scale of generation thus rising from spontaneous generation to sexual and viviparous generation.

Modern science has presented, with reference to this question, a most interesting and most singular double movement in contrary directions. Thus, whilst on one side observers discovered with astonishment in the animal kingdom the reproduction by cuttings and by buds which seemed peculiar to plants; a deeper study led, on the other side, to ascertain the presence of the sexes and of their important functions in those low spheres of animality from which people had been disposed to eliminate them. What can there be more curious, in this respect, than Bonnet's experiments on aphides? He discovers that these aphides are reproduced without any sexual communication, and

by an operation altogether vegetative, which M. de Quatrefages calls *internal budding*. But is that all? Is that their only mode of reproduction? No; for after five, six generations, perhaps more, Bonnet saw the sexes reappear; he saw even these animals couple together, give birth to eggs perfectly characterised, and from these eggs he saw young ones come forth capable of self-reproduction by a kind of parthenogenesis. In the regular class of animals there is, therefore, an alternation of solitary and agamous, and of sexual generation.*

In like manner, Trembley discovers the water-hydra; he finds that the animal multiplies by cuttings; that is to say, in cutting it you can obtain as many individuals as you please, similar to the primitive type. Well! is that all? Is that kind of generation sufficient for the multiplication of the water-hydræ, and, generally speaking, of the polyps? No; and the examples here are so curious, so numerous, and so complex, that I must refer the reader to the interesting work of M. de Quatrefages.† But the fact which seems to result from the magnificent investigations of modern zoologists, is the restoration of sexual generation to the obscure and confused species of inferior animality. These same beings which are reproduced by cuttings and by buds, are also reproduced by eggs through the concurrence of the sexes. M. Ehrenberg, the great micrographer, the Christopher Columbus of the

* Quatrefages, Chap. XIII.

† *Ibid*, Chap. XIII, XIV, XV, and following.

microscopic world, has discovered the sexes in the water-hydræ; M. Siebold, in the medusæ; M. Sieberkühn, in the sponges; M. van Beneden, in the helminthes or intestinal worms; finally, M. Balbiani in the infusoria.

How can we explain, now, such a complication, such an amalgamation of systems of reproduction in the inferior species? How can they reproduce themselves at the same time in such various manners? M. de Quatrefages, whose authority is great on such topics, answers that question in the following manner: "Up to the present time," he says, "the various modes of reproduction had been considered as independent of one another, and, consequently, a degree of importance biologically equal had been ascribed to them. Whether it was an egg, a bulb or a bud, the germ was, in the opinion of naturalists, something primitive; the being to which it gave birth, originated with it alone. Gemmiparous reproduction was thus placed on the same level as reproduction by eggs. Evidently, this was a mistake. Buds, bulbs, whatever appearance they present, are only the more or less mediate product of a preexisting egg; this egg alone contained the essential germ, the *primary germ* of all the generations which are derived from it. Buds, therefore, are only *secondary germs;* and the beings resulting from their developments are mediately connected with the primitive egg. Oviparous reproduction, accordingly, is the only fundamental one; it is a

function of the highest order. Gemmiparous reproduction only comes in as accessory; it is a subordinate function.* Mediately or immediately, every animal can be traced back to a father and a mother (male or female organs); and the same observation applies to plants. The existence of the sexes, the very elements of which do not occur in the unorganised kingdom, manifests itself then, as a distinctive character of the organised beings, as one of those laws established from the beginning of things, and the reason of which we may never hope to discover.†

This restoration of the sexual element in the generation of inferior animals is a fatal blow struck at spontaneous generation. The theory has, besides, suffered many checks not less curious. Thus, for a long time, its upholders could invoke in its favour a fact really strange and, apparently, baffling explanation; we mean the existence of *entozoa* or intestinal worms. "Now," said J. Müller, "it is by the consideration of the intestinal worms that we are chiefly permitted to maintain the hypothesis of unorganised animal matter being transformed into living beings." The existence of these worms which are produced even within the most secret tissues, the interior of the muscles, the interior of the brain, seemed a real mystery; well, this mystery is now explained, and the origin of these strange beings accounted for by the ordinary laws

* Quatrefages, *Ibid.* Chap. XIX.
† Quatrefages, *Ibid.* Chap. XXIII.

of reproduction; only it offers to us one of the most wonderful, most irregular cases of the theory of metamorphoses. That is what the beautiful investigations of M. van Beneden have finally established. Who would have suspected, before the researches made by this *savant*, that a parasitical worm was destined to pass half of its life within one animal, and the other half within another; that he was to live as a fetus in the body of a herbivorous animal, and as an adult in that of a carnivorous one? Such, however, is the fact. These beings change their *hôtels* in some sort. Thus the rabbit gives board and lodging to a parasitical worm which will become an adult only when it dwells in the body of a dog; the *cœnurus* maintained by the sheep will pass to the state of a *tenia* in the body of a wolf. Every parasitical worm goes through three different stages of existence. The first is that of the egg laid in the intestines of a carnivorous animal, and thrown out by it; the second is that of the embryo; the egg is swallowed up by the herbivorous quadruped together with the grass it browses, and it is hatched within its stomach; the third is that of the adult; it takes place within the body of the carnivorous animal, who feeds upon herbivorous beings.* The whole mystery is explained without the slightest reference to spontaneous generation. Besides, the discovery of the sexes and of eggs in the entozoa evidently solves the question.

* Flourens, *Journal des Savants*, May, 1861.

We must, however, acknowledge that there are certain facts still which might be adduced with advantage by the champions of spontaneous generation. The two principal are—1st. The artificial reconstruction of organised substances by chemical synthesis.* 2nd. The resurrection, by humidity, of certain microscopic animals, such as the tardigrades and the rotifers.†

We have already said that the matter which makes up organised beings is the same as that of which unorganised creatures consist. Indeed, all the elements acknowledged by mineral chemistry are not calculated to constitute living matter; but all living matter can be reduced into mineral elements, the principal of which are hydrogen, oxygen, azote, and carbon, to which are added, in smaller proportions, phosphorus, sulphur, iron, and some other less important ones. Thus the hypothesis of Buffon's organised molecules, that is to say, of a special matter peculiar to living beings, is now refuted by organic chemistry. But what is true is this: these mineral elements produce in living beings compounds which we do not meet with in inanimate nature; these compounds are for the most part—as we express it in chemistry—ternary and quaternary; that is to say, they are made up of three or four elements, whilst unorganised compounds are

* See Berthelot, *Chimie Organique fondée sur la Synthèse.* Introduction.

† Dr. Broca's *Rapport sur les Animaux Réviviscents, à la Société Biologique.*

generally binary. These first organised compounds, which are called immediate products, combine in their turn to produce more complex substances, which end, themselves, by forming the tissues and the organs of living bodies. This, then, is the result which organic chemistry had obtained for us. By descending from the compound to the simple, we are enabled to arrive at the elements, azote, oxygen, carbon, &c.; but we could not reascend the scale, and until lately we knew not how to reform artificially the first compounds; in a word, we had an analysis, but no synthesis. Now, in chemistry, synthesis is the proof, the verification, the demonstration of analysis. Something, then, was wanting —analysis did not give all—that *something* omitted by analysis, and which synthesis could not then discover nor imitate, was, according to the greatest chemists, Berzelius, Liebig, Gerhardt, vital force. Well, these first compounds, so long beyond the reach of synthesis, are now reproduced by it—many of them, at least. Already, about thirty years ago, Wöhler had paved the way by the synthesis of urea; but this isolated fact had not opëned the eyes of scientific men, and Berzelius thought that urea is so analogous to mineral compounds, that no conclusion can be deduced from it in favour of the possibility of a more general synthesis. Only, at a later period, thanks to Berthelot's splendid investigations, the solution of the problem has been attained. This eminent chemist, starting from what he calls *slow affinities*, and employing

time as his chief agent, has succeeded in reconstructing, artificially, sugar, ether, alcohol, thereby definitively connecting organic with inorganic chemistry.

If it is possible thus, by new manipulations, to re-create matter which had been hitherto considered as the result of vital force, why should we not one day succeed in re-forming the whole living being?

I shall answer, that, if a question of possibility is mooted, I know not what is possible and what is impossible; if, on the contrary, it is reality which we talk about, the hiatus remains as great as it has ever been between organised and unorganised creatures. I do not dwell upon the differences which physiologists pretend they ascertain between organic matters such as they exist in living beings, and the same matters such as we have them in our laboratories. According to M. Claude Bernard, the sugar which is to be found in our organism is not the same as the one which our retorts give us. I leave this part of the discussion aside, because the difference of the medium would suffice alone to determine some variation in the products. But the capital difference is that loudly proclaimed by M. Berthelot himself, between *organic* and *organised* substances. The former can be created, not the latter; artificial synthesis, up to the present time, has no hold whatever upon anything possessing the attribute of organisation. And here, the question is not about the living being himself, but about his organs, his tissues, his liquids. In a word, the

organised atom, the organic cell is beyond the grasp of chemistry; and nothing, absolutely nothing, tends to show that chemistry will ever be able to solve the problem; for, in reality, what is the fact we are considering? Is it the matter which enters into the constitution of the living being? No; without doubt it is life itself, a mystery of a totally different character.

Is the mystery solved by the resurrection, through the means of humidity, of animals apparently dead —a curious fact which has likewise much occupied the attention of contemporary naturalists? These infinitely small animals can be submitted to an extremely high temperature, which usually kills other living beings; they are dried up to the utmost limits—abandoned to themselves during a certain time; then, if they are placed into a small quantity of liquid, they survive, move, eat, and seem to feel as they previously did. Thus the fact is duly established. There are animals which, dried up as much as possible, can, after a certain time, revive if brought into contact with water. Now, what does this fact prove? Nothing whatever; for if, as I acknowledge, it can be accounted for from the materialist point of view, it offers nothing repugnant to the contrary hypothesis. These beings, you say, were dead, and they have returned to life again. Why should I not suppose that they were not dead, and that this resurrection is only latent life manifesting itself? There are apparent deaths, but there is no instance of any

resurrection. You say every other animal submitted to a similar process of desiccation, or even to an inferior one, would have died, therefore these animals are dead. This is no proof; for, because other animals would have died in these conditions, it does not follow that the animals you are examining are dead also. The same degree of desiccation may not be fatal equally to all organised beings. In the creatures to which you allude, death is followed by decomposition—dissolution. But there is no dissolution here—the organism subsists; it is even indispensable that the organism should not have been touched, for life to manifest itself afresh. Now, if there is a force capable of maintaining organism, why should not this force be capable of producing vital phenomena as before? The author of the report made on this question, at the Biological Society, M. Paul Broca, thinks that *latent life* to be a very metaphysical one, which would subsist in the animal, although the animal gave no symptom of life. The fact is this: here is an animal motionless, completely inert, and which at a given moment, under the influence of certain accidents, moves again, and is endowed with feeling. Let it be chemical affinity or vital force, we have here something which does not manifest itself, but which is capable of manifestation under certain circumstances; we consequently discover here some latent quality. No conclusion can be drawn from it in favour of spontaneous generation.

After having refuted the various arguments

adduced to prove spontaneous generation, in order to convince our readers, it would be enough for us now to explain, with some details, the beautiful and lucid experiments of M. Pasteur on this difficult subject; but how can we give the *résumé* of experiments, the art of which consists especially in the extreme precision of details, and in a sagacity which allows no cause of error to escape? Let us be satisfied with stating the general results of M. Pasteur's investigation. These may be divided into three series.

The first consists in proving that the air holds in suspension organised corpuscules absolutely similar to germs. This fact had been contested, and seemed overturned by M. Pouchet's experiments. Analysing the dust deposited on the furniture of apartments, this gentleman found there few or no germs, or eggs of infusoria. What had been considered as seed were merely grains of paste of various sizes and various structure. Without disputing these results which he has not examined, M. Pasteur remarks that it is not dust in a state of rest on which we should operate; this dust, he says, is exposed to all sorts of currents of air, which must carry away chiefly the organised particles lighter than mineral ones. According to him, what we should study, is dust in a state of suspension in the atmosphere; it is that dust in a state of suspension and of motion which he collects by an ingenious and new method, and which he analyses. Here is the result of these analyses: — "A few very simple

manipulations," he says, "allow us to ascertain that there is constantly in the air a variable number of corpuscules, the form and structure of which show that they are organised. Their dimensions increase from the smallest diameters to $\frac{1}{100}$ $\frac{1}{100}$ of a millimetre, and even more. Some are perfectly spherical, others ovoïd. Their outlines are more or less sharply defined; many are quite translucid; but some of them seem opaque, with granulations inside. The translucid ones, with sharply defined outlines, are so like the spores of the common mould that the cleverest micrographer could not find any difference. . . . But as to affirming that this is a spore, nay, a spore of such and such a distinct species, whilst that is an egg, the egg of such and such a microzoon, I think that is impossible. I confine myself, in so far as I am concerned, to the declaration that these corpuscules are evidently organised, resembling in every respect the germs of inferior organisms."*

M. Pasteur has shown, besides, that the number of these corpuscules diminishes in proportion as we rise in the atmosphere, by virtue of the law of gravitation, which draws them towards the earth; and, in fact, by exposing different liquids in the open air, at various heights in the atmosphere, he obtained generations, so called spontaneous, in in-

* *Mémoire sur les Corpuscules Organisés suspendus dans l'Atmosphère.* On this memoir and on the other works of M. Pasteur, see Laugel, *Découvertes Récentes sur la Chimie Physiologique* (*Revue des Deux Mondes*), September 15th, 1863.

verse ratio of number as he rose higher. And in the vaults of the Paris Observatory, where all the particles of dust must fall to the ground, not being kept aloft by currents of air, he obtained no spontaneous generation whatever—facts perfectly agreeable to the hypothesis of the dissemination of germs.

The second series of M. Pasteur's experiments consists in eliminating, by the most ingenious and best combined precautions, those organised corpuscules which are supposed to be germs; and in demonstrating that under such conditions no infusoria are ever produced. Here begins the critique of M. Pouchet's system of experiments:—Whilst taking all the customary precautions with a view to the destruction of the germs, that is to say, by burning them, by calcinating the air amidst which he pursued his operations, this gentleman nevertheless continued to obtain spontaneous generation. M. Pouchet's error, pointed out by M. Pasteur, consists in the use of the mercury trough. The mercury is covered with germs which are unwittingly introduced into the vases when the operation takes place, and from which the operator believes he has beforehand eliminated them all. The proof of this is, that by varying the mode of experimenting, the spontaneous generations never take place; and, on the contrary, if you take in the trough of any laboratory a single drop of mercury, you obtain with this single drop organised productions, if it is brought into contact with the purest liquid.

The third and most original series of experiments

consists in obtaining or suppressing, *ad libitum*, the production of infusoria by introducing or suppressing the germs collected according to the first method previously described. Here the experiments are too delicate to be stated. I shall merely notice the most remarkable one, the simplest and most decisive. Take a flask filled with a liquid which ferments very easily, give to the neck of this flask different curves by drawing it through the blowpipe; make the liquid boil during several minutes, till the steam comes out visibly from the extremity of the neck, *left open without any further precaution*; the liquid contained in the flask will remain indefinitely unaltered—a strange fact, M. Pasteur observes, and well calculated to astonish all persons accustomed to the delicate character of experiments on spontaneous generation. The circumstance which renders this experiment remarkable is, that usually the greatest precautions are taken to prevent the contact of the atmospheric air. Then, the aperture remaining free, it seems that the air ought to bring in with it the principle of spontaneous generation; but nothing of the kind takes place. The reason is, that the neck of the tube being bent, the germs fall upon the surface, or stop at the entrance, without penetrating as far as the liquid. By way of proving this, if you detach the neck of the flask by one stroke of a file, without otherwise touching the flask itself, you immediately obtain organised productions, the neck being open then so as to allow the germs to fall into the liquid. This

verifying proof can be obtained besides through different methods, equally described, and all agreeing with the hypothesis of the dissemination of germs.

The leader of the new German materialist school, M. Moleschott, says that, because spontaneous generations cannot be obtained artificially, it does not follow that they do not take place naturally. If our chemical and mechanical means are insufficient to produce, artificially, living beings, it does not follow that nature, in order to produce such beings, requires other agents than those supplied by mechanical and chemical forces. Thus, he adds, chemistry cannot produce artificially rocks and minerals; and yet there is no doubt that nature has produced them formerly by chemical means. It is the same with organised beings.

We may answer, in the first place, that the example is very badly selected; for chemistry is precisely on the way, and has been so for a long time, to produce minerals artificially. The first instance of this artificial reproduction has been given by James Hall, who, following the ideas of his master, Hutten, has succeeded in obtaining marble by heating chalk in closed vessels. Messrs. Mitscherlisch, Berthier, Wöhler, Saint-Clair Deville, and Daubrée, have since distinguished themselves by numerous experiments all relating to this branch of mineralogical synthesis.* M. Daubrée has espe-

* On this question, see a concise and learned note of M. Saint-Clair Deville in the charming book of Alexander Bertrand:

cially directed his attention to the reproduction of rocks,* which M. Moleschott declares to be impossible. But, in order to answer completely the objection of the philosopher, we must notice that the experiments of M. Pasteur have much more than a negative character; they have a positive one also; for not only does he show that living beings cannot be produced under certain conditions, he likewise proves that by changing these conditions, living beings are produced *ad libitum;* thus he can, at his will, obtain or withhold organised productions; and that is the true character of a well conducted experiment. But what is that condition, sometimes suspensive, sometimes favourable? It is the absence or presence of germs, the existence of which in the atmosphere has been demonstrated by other experiments.

At any rate, in the experimental sciences no demonstration ever possesses an absolute worth, and the weight of a conclusion can be relative only to the number of facts observed. Therefore we should not say, in an absolute manner, that spontaneous generations are impossible; we must say that, in the actual state of science, there is no well authenticated instance of spontaneous generation; we must say, that wherever the necessary precau-

Lettres sur les Révolutions du Globe, published by his son, M. J. Bertrand, Member of the Institute.

* See his interesting *Mémoire sur le Métamorphisme des Roches,* which obtained the prize at the Institute, and determined M. Daubrée's election as a member of that learned association.

tions have been taken, no such facts could be noticed; we must say, finally, that all the arguments invented in favour of that doctrine have disappeared when brought to the test of experiment. However limited these affirmations may be, they are still highly important, because those who deny them are condemned to support a gratuitous hypothesis. Hypothesis is allowable, no doubt, in speculative sciences, when it is impossible to arrive at the facts themselves; but it should never be gratuitous—never should it be the mere result of a want or desire of our mind. Now, when they maintain that spontaneous generations take place, only because they require such a theory as the support of their system, the materialists indulge in a supposition absolutely gratuitous, the elements of which are not furnished to them by the facts—such as these facts are.

In order to escape from the difficulties just stated, Dr. Büchner proposes a conjecture:—"We might suppose," he says, "that the germs of all living beings, endowed with the idea of species, have existed from all eternity." But it is not hard to perceive in this hypothesis an evident contradiction of the author's general system. For, how have these germs been formed? By what force have the elements of matter combined to produce a germ, and a germ which contains virtually the whole species? That is a point of view essentially idealistic. It is not by its elements, but by its form that a living body is distinguished from the brute one.

Now, if you do not admit the theory of spontaneous generations, this form supposes a special force distinct from matter itself. Besides, the idea of species inherent to the germ is a principle beyond all the data of materialism. The new system, therefore, is convicted of impotency in its propositions on the origin of life. Let us see if it is happier in its endeavours to explain the nature of thought.

VII.

MATTER AND THOUGHT.

At first sight, the hypothesis which reduces thought to be merely a function of the brain seems to offer certain advantages, and to be nothing else but a rigorous application of scientific method: for it rests upon the following propositions. Wherever, it is said, a brain is observed, there we find a thinking being, or, at least, a being having some degree of intellect; wherever the brain is missing, there intellect and thought are equally absent; finally, the intellect and the brain increase and decrease in the same ratio; the cause which affects the one, affects likewise the other. Age, disease, the difference of sex exert at the same time upon the intellect and upon the brain an influence altogether similar. Now, according to the Baconian method, when a certain circumstance produces a special effect by its presence, suppresses it by its absence, or modifies it by its alterations, it may be considered as the true cause of that effect. The brain, in its relation with thought, offers these

three conditions; it is, therefore, the cause of thought.

But I shall notice, in the first instance, that science has a great deal to do before it proves rigorously the three propositions I have just stated. Without alluding to the two first, which are not absolutely incontestable, it is the demonstration of the third especially which is at fault. Before establishing that the modifications of thought are in the same ratio as those of the brain, it would be necessary to know with what circumstance in the brain the fact of thought is precisely connected; and that is what we are quite ignorant of; for some name the dimensions, others the weight, others, again, the circumvolutions, some the chemical composition, and the last, finally, a certain dynamic action which is invisible, but which it is always easy to suppose. Now, according to the opinion of the most eminent *savants*, the physiology of the brain is still in a state of infancy, and the relations between the brain and thought are totally unknown.* For instance, the condition of the brain in madness is one of the most formidable stumbling-blocks in the way of pathologic anatomy. A few philosophers find there something; others, nothing, absolutely nothing. According to M. Leuret, one of the most distinguished alienists, no alteration is discoverable in the brain of a madman, except when madness is combined

* On this question, see M. Lélut's *Physiologie de la Pensée*, and Messrs. Leuret and Gratiolet's *Anatomie comparée du Système Nerveux.*

with some other disease, such as general paralysis. Moreover, the alterations discovered are so different from one another, they have so little constancy and regularity that there is no reason to consider them as true causes. They might indeed be with equal plausibility regarded as effects, because, in course of time, madness can bring on these alterations. In this case they would be, to speak like physicians, consecutive and not essential. A final difficulty arises from the difference between man and other animals. Is this difference sufficiently explained by that of the brain? It does not seem so, since some naturalists insist upon the identity of the brain of man and of that of the ape, to prove that man may have originally been an ape, or, at least, have derived, together with the ape, from a common stem. Here the materialists are considerably puzzled, for sometimes they are interested in proving that man differs from the ape, and sometimes in showing that no such difference exists. Do they wish to prove that man is not a species standing by itself in nature, and that, originally, he may have been blended with inferior species? They point out the analogies. Do they wish to explain the incontestable differences existing between man and ape, such as we both see them now, they insist upon the differences. But these differences, with reference to which the dispute is carried on, and which some men will not acknowledge, are they important enough to account for the chasm which separates both species? Intermediate links are

mentioned; on one side the negroes, and on the other, the gorillas—so popular since M. du Chaillu's travels. Now, I ask, would gorillas be capable of founding the Republic of Haiti, or that of Liberia? Would they even be qualified to take the place of negroes for the cultivation of the sugar cane? Propose this solution to American planters; they will be compelled to acknowledge that negroes are not quite animals. The greater the analogy between the constitution of the negro's brain and that of the ape, the stronger the proof that the difference in the intellect depends upon a certain condition which our senses do not reveal to us.

I add that, supposing the three propositions demonstrated, materialism would not have gained one step in advance, for if we admit that the brain is the condition of thought without being its cause, this is quite enough to allow of the facts above mentioned being explained according to the one hypothesis as well as the other. For suppose, one moment, that human thought were of such a nature that it could not exist without sensations, without images and without signs (I do not mean to say that no kind of thought other than this is possible): suppose, I repeat, that such were the condition of human thought, do you not understand that a nervous system would then be required to render sensation possible, and a nervous centre to render possible the concentration of sensations, the formation of signs and of images? According to that hypothesis, the brain would be the organ of imagination and of language,

without which there would be no thought for the human mind. It would result from this that, as a blind man lacks one source of sensation, and, therefore, one source of ideas, in the same manner, the mind to which a certain part of the brain was wanting, or which was affected in the cerebral conditions necessary for the formation of images and of signs, would become incapable of thinking; since pure thought without any connection whatever with the world of senses, seemed impossible in the present condition of our finite existence. It is seen that the relations of the brain with thought are conceivable as well according to the spiritualist hypothesis as according to the contrary one; and even the difficulties which the latter offers, disappear if we admit the former one. For instance, what would be the cause of the difference between man and other animals? It would arise, no longer from the difference of the brains, but from that of the internal, thinking element which in animals is susceptible of combination only with a small number of images, and which could not transform natural into artificial signs. The physical conditions of thought would be identical in both cases, the entirely immaterial condition of the thinking force being alone modified. It would be the same for cases of madness. These might originate sometimes from organic alterations affecting the organ of imagination and of signs, sometimes from altogether moral alterations which would disable the soul from controlling its sensations, from combining images

and signs, and make it pass from the active to the passive state. If we admit, with certain physiologists, a cerebral dynamism, and if we explain madness and imbecility by variations of intensity in the cerebral forces, why should I not admit an intellectual and moral dynamism residing in an elementary, indivisible substance, and equally susceptible of certain variations of intensity, of which the cause is sometimes in it, sometimes without? It is, therefore, only by placing themselves at a superficial point of view, and by not having sufficiently examined all the aspects of the question, that materialists have fancied they could conclude that the brain is the subject itself of thought, from the fact that it is indispensable for the production of thought.

But it is not sufficient to show that the facts adduced by materialists are also explained and most satisfactorily explained according to the contrary hypothesis; for then it would merely follow that the mind ought to remain undecided and indifferent between the two suppositions. We go further; there are certain facts decisive, according to our own opinion, certain pre-eminent characteristics of thought which seem absolutely repugnant to materialism. Every one knows what these facts are. Whoever has studied this question with the slightest care, guesses that we allude to personal identity, and to the unity of thought. These facts are well-known, and their consequences have been a thousand times explained. Is it our fault if the materialist school systemati-

cally omits them, and is always obliging us to oppose them once more to its pretensions?

Personal identity is not defined, it is felt. Each one amongst us knows that he remains the same at every instant of the duration which constitutes his existence, and that is what is called identity. Thought, memory, responsibility, are the three leading facts which manifest identity with the greatest clearness. The simplest fact of thought proves that the thinking subject remains the same at two different moments. Every thought is successive; if this assertion is contested as far as judgment is concerned, it cannot be for a moment disputed with respect to reasoning; if, however, it is disputed with reference to reasoning under its simplest form, it must be admitted for demonstration which consists of a series of reasonings. Every one must acknowledge that it is the same mind which passes through every stage of a demonstration. Suppose three persons, one of whom thinks a major, the second a minor, and the third the conclusion: will you have a common thought, a common demonstration? No; the three elements must combine to form one whole in the same mind. Memory leads us to the same result. I only remember myself, said very truly M. Royer-Collard: external beings, other persons, enter into my memory only on condition that they have previously entered my knowledge; it is that knowledge which I remember, and not the thing itself. I could not then remember what another person than

myself has done, said or thought. Memory supposes a continuous link between the *ego* of the past and the *ego* of the present. Finally, no one is responsible except for himself; if he is so for others, it is in proportion as he has been able to act upon them or through them. How could I answer for what another person has done before I was born? Thus thought, memory, responsibility—such are the three striking evidences of our identity. This, then, is one of the capital facts which characterise the mind.

There is, likewise, in the human body a leading and characteristic fact, but which is the contrary of the preceding one: it is what we call the vital vortex, or the perpetual interchange of matter which takes place between the living bodies and the external world. This fact manifests itself by the phenomenon of nutrition. We know that organised bodies require nutriment; that is to say, they are obliged to borrow from foreign bodies a certain quantity of matter in order to repair the losses they are continually sustaining; for, if living bodies, while appropriating continually fresh matter, preserved at the same time all they had previously acquired, we should see their dimensions increase without ceasing; this, indeed, is what we perceive up to a certain age—but the movement of increase stops, and the body remains stationary in its dimensions. It is evident, then, from this very fact that the body loses nearly to the amount of what it gains, and that life is only a circulation. The greatest naturalists, besides, have recognised this

truth. I shall quote especially the eloquent words of Cuvier:—"In the living bodies," says he, "no molecule remains stationary, they all enter and depart successively—life is a continual vortex, the direction of which, complicated though it be, remains constant as well as the kind of molecules which are carried along by it, but not the individual molecules themselves. On the contrary, the present substance of the living body will soon have disappeared; and yet it contains the force which will oblige the substance to come to follow the same direction. Thus the form of those bodies is more essential to them than their constitutive matter, since this is continually changing, whilst that remains the same."

Without insisting here upon a fact which we have already mentioned, and the confirmation of which will be found in the works of all physiologists, let us say that the problem, for materialists, consists in reconciling the personal identity of the mind with the perpetual mutability of the organised body. Now, we must acknowledge that materialists have never taken much trouble to solve that problem, and Dr. Büchner does not even allude to it; and yet it is not clear that the identical can result from the variable, or the one from the compound. If facts thus take place, still it would be necessary to tell us how they *do* take place.

The first explanation which might be given is the one indicated in the passage from Cuvier, above quoted. This vital vortex, it will be said, has a

constant direction; amidst the alteration of matter, there is something which remains ever the same—and that thing is form. The materials are displaced and replaced, but always in the same order and in the same relations. Thus, despite the alterations of the parts, the features of the countenance always preserve nearly the same character; a scar always remains, although the wounded molecules have long since disappeared. Thus the living body possesses in some sort an abstract individuality resulting from the persisting nature of the relations of part to part, and which is the foundation of the identity of the *ego*.

Such an explanation can satisfy only those who do not understand clearly the conditions of the problem; for, supposing that the fixity of the type, either individual or generic, can be accounted for by a simple evolution of matter, by chemical or mechanical agencies, we must not forget that an identity thus produced will never be but an apparent and altogether external one, similar to that of those petrifications, where all the vegetable molecules are by degrees replaced by mineral ones without any alteration in the form of the object. I say that such an object is not really identical, and especially that it is not so for itself; and that by adopting such an hypothesis you preserve no foundation for the consciousness and the remembrance of identity. For, I ask it, where will you place remembrance in an object which is ever changing? will it be in the elements, in the molecules themselves? But, since

these molecules must disappear, those which arrive cannot remember those which depart. Is it in the relation which exists between these elements? Such ought to be the conclusion; for the relation is the only thing which really remains permanent; but what is a relation which is the object of its own thought, of its own recollection, and which is responsible? These are so many unintelligible abstractions which we spare our readers.

One might turn to the following hypothesis: In proportion as the molecules enter the body, the brain for instance, they occupy the place where the preceding molecules stood; they find themselves, then, in the same relation with the neighbouring molecules —they are carried along in the same vortex as those whose place they fill. Well, if by supposition, thought is a vibration of the cerebral fibres—since everything now-a-days is explained by vibrations—each new molecule will come in its turn to vibrate exactly as the former one did; it will give the same note, and you will believe you hear the same sound, it will then be the same thought as just now, although the molecule has changed. Having the same thoughts, man will be the same individual. Yet such an explanation has nothing satisfactory about it, for the identity of the person is not attached to the identity of thoughts. I may be tossed about between the most contrary ideas, the most opposite sentiments, without ceasing to be myself; and, on the contrary, two men thinking the same thing at the same time, as, for instance, the

series of numbers, will not become for that reason one and the same man; several chords producing the same note are not the same chord. Thus the consciousness of personal identity is not explained by the identity of vibrations any more than by the persistence of form.

It may further be answered: You argue according to an hypothesis which is not the true one. You seem to think that the brain of man changes totally every minute, every second. Such is not the case. The alterations of the brain are only successive. On the other hand, is the *ego*, then, immoveable? Does it not change every moment? Is the young man the same as the full-grown man—the full-grown man the same as the old man? Thus neither is change absolute in the body, nor immobility in the soul. Could we not come to an understanding on this ground? The consciousness of identity might correspond in us to the lasting portion of the brain, and the consciousness of change to its variable part. Then would be united in man, according to Plato's expression, the *one* and the *several*, the *same* and the *different*. That is, I believe, the deepest assertion which can be made in favour of materialism; but I do not think that our opponents have ever taken the trouble to go so far in the justification of their cause; it is we who consent to place weapons in their hands. But whether this be so or not, this last suggestion does not satisfy me more than the foregoing ones. In the first place, there would be this strange circumstance, that man at each mo-

ment would lose part of himself, and also at each moment re-complete himself. At the end of a certain time, I should have only three-fourths of what I was before, then the half, then a quarter, then nothing. Is that a faithful description of what we experience when we feel we are changing? The phenomena vary, but we ascribe them all to the same individual. There are variations of intensity in the consciousness of that permanent *ego;* there are disturbances, revolutions, a thousand accidents, but the being itself persists, and always remains, notwithstanding the failings, the excitement, and the troubles of every kind to which it is a prey.

And besides, these organic changes, although they take place more slowly, do not the less produce the same effects in the end. After a lapse of some years, a new *ego* would have succeeded the foregoing one. Let us suppose the renewal occurring in four intervals corresponding to the four ages of life; there will be, then, an *ego*-child, an *ego*-adult, an *ego* in a state of maturity, a fourth one in old age! But we have thus four different men inheriting, in some sort, from one another. How can they combine to form one single man, knowing his own powers, enjoying the consciousness and the recollection of his identity? and that, too, will be merely an apparent identity like unto that of a public office successively occupied by men following the same track as their predecessors, but really differing from them.

Let us examine a final hypothesis: It may be

said that everything does not change in the living body, but that it has in itself something immutable, and that something is also the foundation for it of individuality and identity. Who affirms that the entire brain is continually renewed, that there is not in that organ a last substratum inaccessible to change? This hypothesis is the more plausible because we do not witness the renewal of the cerebral matter. I answer, in the first place, that no experiment confirms this assertion; it is a mere hypothesis, like the soul, which you call an hypothesis. There is nothing here, then, which can be an advantage to you from the point of view of observation; now the favourite pretensions of your materialists, is to rest upon observation. In the second place, that immutable matter, concealed within the depths of changeful and visible matter, that hypothetic matter constituting, according to your opinion, the individual and identical being, is it organised or not? If it is organised, how can it escape the fate of organised matter, of which the fundamental law is nutrition; that is to say, the exchange of its constituent parts, or in other words, motion? How, then, could it be immutable? Is it unorganised? But, then, where have you found that unorganised matter is susceptible of thought? Experience presents to us thought only in connection with organised matter. Thus this existing matter would be similar neither to organised nor to unorganised matter; that is to say, to the two only kinds of matter with which we are

acquainted. It is, then, a matter which cannot be observed, and which therefore falls under the objection which you raise against the soul. It is a gratuitous hypothesis required by the want of your cause, but in no wise supported by facts.

I confine myself to the foregoing remarks derived from the identity of the thinking subject; as to those which are deduced from its unity, they are so thoroughly known and so vulgarized, that it is useless to dwell upon them; they are, besides, of the same kind as the observations I have stated. I shall limit myself to a few general indications.

The unity of the *ego* is an undoubted fact. The whole question is to know whether that unity is a result or a primary fact. But if the unity of the *ego* is a result, conscience which attests to us this unity is a result likewise; and this is indeed what is maintained, not only by the materialist, but also by the pantheist school. Yet this fact has never been proved, nor even explained. For how can we admit and understand that two distinct parts can have a common consciousness? I understand that an altogether external individuality can result from a certain combination of parts, as in an automaton; but such an object will never be, for itself, an individual; it will never be conscious of being an *ego*. Now, for materialism, man can be nothing but an automaton, infinitely more complicated than those produced by human industry; but, after all, similar to them. In what part of such a machine can the consciousness of the *ego* reside?

If you admit, as Diderot seems to do, together with Leibnitz, that there is in the very elements of matter a beginning of consciousness, and a kind of rudimentary perception, I say that this is possible only on condition that these elements or atoms are absolutely simple and irreductible; that is to say, if they are true *monads*, according to the expression of Leibnitz. But, then, why should you refuse to admit that some of these monads can pass from a rudimentary and incomplete consciousness to a clear and distinct one—from inertia to life, from life to sensibility, from sensibility to thought? and would not such monads be real souls? If you persist in maintaining that the sum total of consciousness is produced only by the addition of those imperfect *consciousnesses*, I persist in maintaining that, supposing you were to add together all the consciousnesses of the universe, you could never form thus one individual and sole consciousness. Unity, externally perceived, may be the result of a composition; but it cannot be so when it perceives itself from within.

VIII.

FINAL CAUSES AND THE TRANSFORMATION OF SPECIES.*

Dr. Büchner, as we have seen, refuses, together with all materialists, to admit any final cause in nature; and here he is authorised in some sort, we must acknowledge, by the undisguised aversion which the greater part of *savants* profess for final causes. I have some difficulty, I confess, in accounting for such an aversion. How, then, is the supposition of a plan and a design in nature (for that is the sum of the doctrine of final causes), contrary to scientific spirit? We must carefully distinguish here two classes of ideas—the method and the things themselves. The method of final causes may be barren, and even injurious to science, without the consequence being that there are really no final causes at all. No doubt, if we begin by supposing that such a phenomenon has an end, and a certain end, we may be thereby led, in order to reconcile things with this imaginary end, to suppress real

* I am preparing on the theory of final causes a special and developed treatise, from which the following chapter is detached.

facts, and to introduce fanciful ones; we must not then start from a preconceived idea, which experience might belie; but if this is a bad method to discover facts (and is this even true without restriction?) does it follow that facts, once discovered, will not reveal adaptations, a plan, an intention, a finality? Why should our objectors maintain, *per fas et nefas*, that nothing similar exists in the things themselves? Is not this prejudice as dangerous, as delusive, as the former one, although it is contrary to it? The desire of not finding final causes in nature may lead me to chimerical theories quite as much as the opposite wish. Thus the true principle of scientific method in this circumstance should be indifference, and not hostility to final causes. A celebrated naturalist of our own day, M. Flourens, has very truly said, "We must proceed, not from final causes to facts, but from facts to final causes." It is in the same sense that Bacon banished them from natural philosophy in order to place them in the domains of metaphysics.

Besides, it seems that the chief of the new German materialist school, M. Moleschott, is disposed to retrace his steps in this question. For, in an introductory address, recently delivered at Turin, where he has just been named Professor, we find these singular words: "Do not believe that I am rash enough, or blind enough to refuse to nature a design and an end. All those whose ideas I share, by no means deny the τελος which they guess, which they even sometimes perceive in nature, as Aris-

totle did before them. But they wish to forewarn the investigator against the maze in which his researches would be lost, if he endeavoured to guess, instead of being satisfied with the *rerum cognoscere causas.*"*

The naturalists persuade themselves that they have banished final causes from nature, when they have demonstrated how certain effects result necessarily from certain given causes. The discovery of efficient causes seems to them a peremptory argument against the existence of final causes. We must not say, according to them, "that a bird has wings *in order* to fly, but that he flies *because* he has wings." But how, I ask, are those two propositions contradictory? Supposing that the bird has wings *in order* to fly, must not his flight result from the structure of his wings? And thus, because flight is a result, you have no right to conclude that it is not also an end. To make you acknowledge in nature a design and a selection, would it then be necessary for nature to display effects without cause, or effects disproportionate to their causes? Final causes are not miracles; in order to arrive at a certain end, the Author of all things must have selected secondary causes precisely adapted to the desired effect. Consequently, what is there astonishing that in studying these causes you should be able to deduce mechanically the corresponding effects? The contrary would be impossible and absurd. Thus, explain to us as much as you please that, a

* *Revue des Cours Publics Scientifiques*, January 18.

wing being given, the bird must necessarily fly, this does not at all prove that the bird has not wings in order to fly. In good sooth, if the Author of nature wished birds to fly, what better plan could be followed than that of giving them wings?

This agreement between efficient and final causes has been admirably expressed by Hegel in the following *spirituelle* and profound remark: "Reason," he says, "is as cunning as it is powerful. Its cunning consists in that, whilst it allows things to act upon one another agreeably to their nature, and to wear themselves out in this work without mixture or confusion, it only thereby realises its own ends. We may say in this respect, that considered in its relation with the world, and with the events which take place there, Providence is absolute cunning. God leads man to find his satisfaction in his own private interests and passions, whilst He Himself accomplishes His purposes, which are different from those contemplated by man's passions and interests."

I need only recall the well-known facts, so often quoted, which induce us to believe that nature, at least in living beings (I omit the rest), has followed a plan and a design, has proposed to itself an end, and has sought the best means of realising that end. The principal of these facts are the structure of the organs so well adapted to the functions they have to discharge: as the eye for the sight, the heart for the circulation of the blood, the appropriation of the organs to the medium in which the animal lives, as the lungs for breathing in the air,

and the gills for breathing under water; the correlation of the organs with one another, especially the relation, so much dwelt upon by Cuvier, between the structure of the teeth and the skeleton of the animal; the sexes, so wonderfully combined for each other; the secretion of milk in the breast after parturition in the class of mammalia; the industrious instincts of animals, &c. All these facts have been so often developed, especially during the eighteenth century, that we shall be satisfied with indicating them by referring our readers to the works, so remarkable and too much forgotten, of Nieuwentyt, and Paley, and finally Reimarus, the teacher of Kant, who names him several times with respectful admiration. Well, in the presence of so many various examples, having so clear a signification, shall we not be allowed to say, as *savants* do say in similar circumstances, that everything takes place *as* if the cause, whatever it may be, which has produced the organs in the living being, had had in view the special effect which each organ had to produce, and the common effect which they were to produce altogether; in other terms, that that cause has had a plan, and has proposed to itself an end? This end, foreseen and determined before hand, is what we call a final cause.

Let us, however, take care we do not allow ourselves to be conquered by imagination and by habit. The hypothesis of final causes is, perhaps, as Epicurus and Spinoza have thought, only the ignorance of true causes; perhaps a deeper study will teach us

to discover some real cause which at present escapes us, and unfold before us a natural effect where we believe we see the mark of a provident will. Thus, in the sleight-of-hand tricks by which a conjuror dazzles us, we might be led to believe in some magical and supernatural power, because we do not know the causes, very simple and often very obvious, which produce such wonderful effects. Cannot nature, also, be a conjuror, hiding from us its springs, its agencies, its play, and throwing us, as Spinoza says, into stupid astonishment by showing to us the effects, whilst it conceals the causes?

For a long time the materialist school of philosophy, knowing no more of the laws of nature than the opposite metaphysicians, was satisfied with ascribing to chance and to fortuitous coincidences those harmonies and those adaptations which astonish us. This vague appeal to fortuitous causes left all its force to the argument which the spiritualists derived from the order of the universe. For, to say with the Epicureans of old, that the earth, fruitful and softened, can have produced originally, by a spontaneous virtue, all sorts of living beings—that the atoms, by combining together according to the laws of gravity and of *clinamen*, have brought plants here, animals there, here fishes, and there men;—that millions upon millions of forms have been created which, being unfit for life, have succumbed; that halves of living beings have been seen issuing from fetid mud with unfinished bodies; that all sorts of organs have met at random, and that

finally, out of these meetings a certain number have been favourable, and produced plants, and animals, such as we know them—a system of the kind, and it is that explained by Lucretius, is so coarse and clumsy that it was formerly a piece of good luck for spiritualist metaphysicians to have to refute it. The extravagance of such explanations, the very absence of all explanation, proved here, better than any argument, the impossibility of removing from the universe a foreseeing and intentional cause.

But in these latter days, since about half a century, science has vigorously grappled with this problem; it has endeavoured to reduce the great mystery of organic adaptations to certain definite causes, to certain natural laws. It could not be satisfied with so blind an interference of fortuitous causes, and it has tried to establish a relation more precise, more probable, between causes and effects. It has understood that people say nothing, in point of fact, when they say that matter, by combining, has produced living beings; for the problem consists precisely in explaining how matter can have produced beings fit for life. It was necessary to find some precise and special reason for these wonderful adaptations, which fate cannot account for. Hence several hypotheses, more or less specious, which materialism has hastened to claim; and, in order to tell the truth, we must acknowledge that the contest has become more serious than it formerly was.

Amongst these hypotheses, one of the most inte-

resting and the most ingenious, is that which a celebrated English naturalist, M. Darwin, has quite recently developed with infinite learning and talent in his book on "The Origin and Formation of Species." This work, invoked by Dr. Büchner, as a striking confirmation of his doctrines, deserves an attentive discussion. But let us first recall the analogous hypotheses which have preceded his own, and to which he himself assigns a certain part in his doctrine.

Several principles, or agents, have been proposed in order to explain the organic adaptations without any reference to final causes. The chief are the action of media, habit, and want. It is by the combined actions of these agents that Lamarck explains the progressive transformation of animality, which, according to him, has risen by continuous perfection from the most elementary to the most complex form, from the monad to mankind;—a remarkable theory, which Diderot, in the fruitful boldness of his inventive imagination, seems to have first dreamt; and which an adventurous mind of the last century, Benoît de Maillet, developed in anticipation of Lamarck, in a book half ridiculous, half profound, the *Telliamed*, which has called forth the jokes of Voltaire, and the majestic contempt of Cuvier.

There is no doubt that the external conditions in which an animal finds himself placed, act upon him, and modify him in a certain measure. It is the *ensemble* of these conditions (air, water, meteorological accidents, education, &c.), which is called the

medium. Well, say some naturalists, if it is the medium itself which, shaping, binding the animal to its influences, fits it to live precisely in the midst of those influences, should we have any reason to be astonished at the agreement existing between the organs and the medium? as if we should be astonished, for instance, at a river finding precisely the bed ready to receive it, whilst it is the river which makes its own bed? That would be arguing in a circle. Thus again, would it be reasonable to say that peasants have been endowed by nature with a vigour of organisation greater than that of other men, because they were destined to undergo greater atmospheric inclemencies—heat, cold, rain, snow, wind—and that Providence has thus reserved for them more chances of preserving their existence, which is necessary for the welfare of mankind? Is it not manifest that by reasoning thus, we should be taking the effect for the cause? For if peasants are strong, it is precisely because they have had to resist numerous physical accidents which strengthen those whom they do not kill. Final causes of this kind cannot be admitted by anybody. Well, if it could be proved that all organic modifications have for their cause the action of a medium, would not the severest blow have been struck at the doctrine of final causes?

We must acknowledge that external conditions act upon the organisation, and modify it; but how far, and in what degree? That is the great discussion which divides naturalists, and which suggests,

to-day, important experimental researches. We have no intention to dwell upon it. Up to the present time, however, it does not seem that the action of media, such as we can know and observe them, penetrates very deeply into the organisation. The most important are those artificially produced by domestication; but have we ever succeeded in creating one single organ? However great we may suppose the share of these external agencies, it will be difficult to admit that they can determine the formation of the most complex and important organs. For instance, certain animals breathe by lungs, and others by gills; and these two kinds of organs are perfectly appropriated to the two media of air and of water respectively. How can we conceive that these two media have been able to produce organs so complex and so thoroughly adapted to their ends? Out of all the facts established by science, is there a single one that can justify so evident an application of the agency of media? If I am told that the word medium signifies, not only the element in the midst of which the animal lives, but every kind of external circumstance, I shall require my opponents to determine what is the precise circumstance which led this organ to assume the shape of lungs, and that to become gills; what is the precise cause which has made the heart—that hydraulic machine, at once so powerful and so easy, and the movements of which are so curiously combined for the purpose of receiving the blood coming from all the organs of the body, and of sending it

back to them? Finally, what is the cause which has united together all those organs, making of the living being, according to Cuvier's expression, "one isolated system, all the parts of which concur to a common action by a reciprocal reaction?" What will it be if we pass on to the organs of the senses—to the most wonderful of all, the eye of man, or that of the eagle? M. Darwin himself stops for a moment, almost frightened by the problem. The *esprit de système* which supports him carries him on; but, amongst the *savants*, who have no preconceived theory, is there one who would dare to maintain that he has the slightest glimpse of the manner in which the light could have produced by its action the organ appropriated to it? or else, if it is not the light, what is the external agent powerful enough, clever enough, ingenious enough, expert enough in geometry, to construct that wonderful apparatus which has made Newton say: "Is it possible that He who made the eye did not know the laws of optics?" A grand saying which, coming from so illustrious a philosopher, ought to lead for one instant to reflection those improvisators of cosmogonic systems, so learned on the origin of the planets, and who so fondly pass over the origin of consciousness and of life!

It would seem that the coloration of the skin is the phenomenon the most easily explained by the action of media. Now, there is even a dispute, and a dispute which has been prolonged amongst naturalists, to know if the difference of medium

can explain the difference existing between the Caucasian race and the Negro one; and even, by a singular contradiction, the very naturalists, so favourable to external actions when the question is of assimilating the ape to man, become most exacting and most incredulous when people endeavour, by the same actions, to account for the difference between the white and the black men. Without entering into this discussion, I shall be satisfied with saying, that if the unity of the human species is still a problem for naturalists, *a fortiori* is it the case for the unity of the whole animal kingdom.

Besides, there is a fact which proves, better than any argument, the insufficiency of the principle of media; and it is this:—the naturalists most favourable to that principle have not felt satisfied with it, and have invoked others at the same time. There is even now a remark we must make which is not devoid of interest: the naturalist who is considered as having attached most importance to the action of media, Lamarck, understands this action in a sense very different from that which might be expected, according to the received opinions; for he ascribes to the medium a perturbing, much rather than a plastic, action.

According to Lamarck, the fundamental law is the progressive complication of organisms. Now, it is not the medium which produces the progression; on the contrary, the medium, or modifying cause, only disturbs it—it is the cause which brings about interruptions, gaps, real disorders, and which

prevents the animal series from presenting that graduated and continuous scale which Bonnet had defended, according to the well-known principle *natura non facit saltus*. What, then, in Lamarck's opinion, is the true principle which presides over the formation of animality? It is a principle distinct from the medium, independent of it; a principle which, left to itself, would produce an uninterrupted series in a perfectly graduated order—it is what he calls the power of life. "Every thing here," says he, in his bad style, "rests upon two essential bases, regulating observed facts and the true zoological principles, viz.: 1st. The *power of life*, the results of which are the increasing complication of the organism, and consequently the aforenamed progression. 2nd. The *modifying cause*, the results of which are various irregular interruptions and deviations in the power of life. From these two essential bases it follows, first, that there exists a real progression in the composition of the organisation of animals, progression which the modifying cause has not been able to hinder; secondly, that there is no permanent and regular progression in the distribution of the races of animals, because the modifying cause has almost everywhere made to vary that which nature would have formed regularly, if that modifying cause had not been in action."*

This distinction between the perturbing action of the medium and its plastic action, is of the highest importance with reference to the question

* Lamarck, *Histoire des Animaux sans vertèbres*, Vol. I.

which occupies us; for the adaptation of the organs to the functions no longer being the result of the medium, but that of life, the whole problem remains what it was before; and we still require to know how life, a blind and unconscious cause, can adapt all the parts of the animal to their respective uses, and connect them together towards a common action. In this doctrine, the medium can no longer be claimed as a cause, since it is only an obstacle, and without it the organic forms would be still more regular and more harmonious than they are.

The medium being then, as Lamarck himself acknowledges, a principle insufficient to explain the production of organic forms, and, consequently, their appropriation, will, what he designates as the power of life, be attended with greater success, and by what means will that effect be produced?

Here Lamarck appeals to two new agents, which we have already pointed out—habit and want. He states two laws: the first, that want produces the organs; the second, that habit developes and strengthens them.

Let us insist upon the difference which exists between these principles and the foregoing one. According to the hypothesis of the medium, the modifying and transforming cause is altogether external. Nothing comes from the transformed object. It is like the wax in its relation with the hand which shapes and moulds it. Such is the case of the rocks, which, under the action of waves, are hollowed, and become grottos, temples, and palaces.

Evidently there is here no premeditated adaptation. Is it the same case when you bring in the power of habit or that of want? no, of course; for the causes we find here are not external, but internal ones; although determined by external circumstances, they act from within—they co-operate with the medium. They it is, and no longer the media, which adapt the living being to his conditions of existence. Well, if we suppose that these causes can account for all organic adaptations (and that is more than doubtful), nothing yet would be gained, for this power of adaptation is itself a wonderful adaptation. Here we have not only, as just now, a physical cause moulding the animal or the plant from without; we have an internal power concurring with the external action, and accommodating itself to the wants of the living being.

What then? There is in the living being a power, such that if the medium is modified, the living being modifies itself also, in order to be able to live within that new medium! The being has the power of accommodating itself to external circumstances, of making use of them, of applying them to its wants; and in such a power you do not perceive a finality! Imagine the living being having the hard and inflexible nature of stone and of metal, and each alteration of the medium becomes for it a cause of destruction and of death; but nature has made it supple and flexible. Now, in such a flexibility, I cannot help acknowledging a thought which preserves life throughout the universe.

This will be better seen if we examine the subject more closely. We must admit here two cases: either the animal is conscious of its existence, or not; for the inferior animals, according to Lamarck, are deprived of sensibility as well as the plants. In this second case, Lamarck maintains that the production of an organ has an altogether mechanical cause; for instance, "a fresh motion produced in the fluids of the animal." But then, if the organ is only the result of a mechanical cause, of a movement of fluids, without any feeling, and consequently without any effort, how does it happen to be in any wise adapted to the animal's wants? How will the fluids go precisely towards the point where the production of an organ would be necessary? And how could they produce an organ adapted to the medium in which the animal lives? As for saying that all sorts of organs are produced, some useful, others useless, others, again, hurtful, and that the animal subsists only when the number of useful ones predominates—is not this simply returning to the hypothesis of Epicurus, and ascribing everything to chance, the only conclusion we wanted to avoid? Besides, are the facts in accordance with such a supposition? If the combinations of organs are fortuitous, the number of useless or hurtful ones should be infinitely greater than it is (on the supposition that there is even one simple organ of the kind, which is not proved); for these two conditions do not positively exclude life. And if we say that such has been the state of things formerly,

we launch forth into the unknown; besides which, the palæontological discoveries do not lead us to suppose that fossil animals were more imperfectly constructed than those of the present day.

If, on the contrary, it is a felt want which itself determines the direction of the fluids, how will the fluids move precisely in the direction where the want exists, and produce precisely the kind of organs necessary for the satisfaction of the want? An animal feels the want of flying, in order to escape from the reach of dangerous enemies; he makes an effort to move his limbs in the direction where he may, with the greatest ease, avoid their pursuit. How can the effort and the want combined succeed in making the fore limbs assume the shape of the wing—that machine so delicate and so skilfully arranged, that the most subtle mechanical notions in man can scarcely conceive how it is possible to imitate it? In order that the motion of the fluids may bring about such difficult combinations, something else is wanted than a vague want and an uncertain effort.

Lamarck acknowledges that "it is very difficult to prove by observation how the want produces the organ;" but he maintains that the truth of this first law is logically deduced from the second law, which experience attests, and according to which the organ is developed through experience and through habit. Then, if we believe him, because habit developes the organs, it follows that want can create them. Who does not see the abyss which lies

between these two propositions? What! because a given organ increases, and is developed through exercise, it will be concluded that want can produce an organ which does not exist? Can the production of a non-existing organ be compared to the development of an existing one? We see clearly that exercise increases the dimensions, the strength, the facility of action of an organ; but we do not see that it multiplies it and changes its essential conditions. The mountebank has muscles more delicate than those of other men. Has he other muscles? has he more muscles? are they differently disposed? In good sooth, how far soever the power of habit is supposed to go—can it go as far as creation?

I know that the theory of the unity of compositions may be invoked; it may be maintained, as the disciples of Geoffroy Saint-Hilaire do, that all the organs are nothing else really than one and the same organ diversely developed; and that, therefore, exercise and habit may have been able to produce successively, although slowly, those varieties of form which are only differences of development. But is not the doctrine of organic unity itself a mere hypothesis, when it is carried so far? Cuvier's great objections against this hypothesis, have they been all set aside by modern science? Is not the unity of type and of composition in the animal series an ideal and an abstraction, rather than the exact and positive expression of reality? And, besides, would it be sufficient to show that two

different organs are analogous to one another,—that is to say, according to Geoffroy Saint-Hilaire, situated in the same place, and connected by the same relations with the neighbouring organs,—to conclude, from such a fact, that one of these organs has been able to assume the form of the other? No; we should see that organ itself passing from one form to another. Otherwise, the analogy does not prove that the transition exists. Thus, for instance, because the elephant's trunk is analogous to the human nose, it does not follow that the nose can be transformed into a trunk, or *vice versâ*. Geoffroy Saint-Hilaire, besides, has taken care himself to separate his hypothesis from that of Lamarck; and he wittily said that a palace and a cottage can be affirmed to correspond to one simple fundamental type, without the affirmation following that the palace has begun by being a cottage, and that the cottage will become a palace.

There are cases where analogy is certain, and transformation possible; but where, nevertheless, it is difficult to understand how habit could have brought about that transformation. Thus it seems proved in comparative anatomy, by the researches of Göthe and of Oken, that the cranium is analogous to the vertebrae—that it is, itself, an enlarged and developed vertebra. Well! how can habit have brought about such a metamorphosis, and changed the topmost vertebra of the back bone into a cavity capable of containing the brain? Here is what we should have to suppose:—An animal having only

the spinal chord, by dint of exercising it, has succeeded in producing that expansion of nervous matter which we call the brain; and in proportion as this superior part became enlarged, it drove back the covering, soft in the first instance, which enclosed it, until it had compelled it to assume its own shape, that of the cranium. But how many hypotheses in that hypothesis! In the first instance, we must imagine animals having a spinal chord, and yet destitute of brains; for if both these organs always appear together, and nothing indicates that the one has preceded the other; and it is as plausible to consider the spinal chord as a prolongation of the brain, as it is to look upon the brain as an expansion of the spinal chord; a fact which seems to point out to such a conclusion is, that a substance analogous to the brain is found even in animals which have no spinal chord, in the molluscs and articulated animals. Now, if the brain pre-exists in the vertebrated animals, the cranium pre-exists also; it is not, then, the result of habit. Let us add, that it is difficult to understand exercise and habit being produced without the brain; they are facts resulting from the will, and it seems certain that the brain is the organ of the will. Add, finally, that we should have to admit the bony substance to have been in the first instance cartilaginous, in order that it might adapt itself to the successive enlargements necessitated by the progress of the nervous system, a circumstance which would imply a remarkable adaptation in the original

suppleness of the bony matter, without which the development of the nervous system would have been impossible. I leave to zoologists to decide whether all the hypotheses I have just stated are plausible, and agree with the facts.

We may be allowed, besides, to quote here, in our favour, the authority of the illustrious Cuvier, who judges most severely Lamarck's hypothesis:* "Naturalists, most material in their ideas, and not even suspecting the philosophical observations we have just mentioned, have remained the humble followers of Maillet (Telliamed); seeing that the greater or less use of a limb increases or diminishes sometimes its power and its volume, they have imagined that habits and external influences, long continued, were able to change by degrees the forms of animals, so as to make them arrive successively at all those which the different species at present exhibit; the most superficial idea, perhaps, and the vainest of all those which we have had already to refute. They consider, in some sort, the organised bodies as a simple mass of paste or clay susceptible of being moulded by the fingers. Accordingly, as soon as these authors have wished to enter into details, they have become ridiculous. What man dares to maintain, seriously, that a fish, by dint of remaining on dry land might see its scales split themselves and change into feathers, and itself become a bird; or that a quadruped, by dint of creeping into narrow passages, and of passing

* Cuvier, *Anatomie comparée*, Tome I, les. 1, art. v.

through a process of gradual reduction, might transform itself into a serpent? Such a man would merely give evidence of the most complete ignorance of anatomy."

I shall not dwell at any further length upon Lamarck's theory, its insufficiency being demonstrated by the system which M. Darwin has endeavoured to substitute for it. We are justified in questioning the modifying power of media and of habits when we hear the above-named naturalist saying, "that he has not great confidence in the actions of such agents." What is the one which he substitutes for it? This is what we have now to examine.

The fact which has served as a starting point for M. Darwin's system, is so prosaic and so vulgar, that no metaphysician would ever have condescended to glance at it. Metaphysicians must, however, accustom themselves to consider not only what is above our heads, but what is at our side and at our feet. What! did not Plato admit that there is a divine idea even for dung,—even for mud? Let us not disdain, therefore, to enter, with M. Darwin, the stables of graziers; to seek, in his company, for the secrets of the breeding of oxen, horses, pigs, and, in these productions of human industry, to discover, if possible, the contrivances of nature. No doubt, when, some years ago, an International exhibition brought together in Paris, the finest specimens of these various modes of industry,—when every year now, in the competitions which take

place in the several departments, we see prizes awarded to the finest results of cattle breeding, nobody would have believed—nobody could believe —how that the interests of the theodicy were at stake. And yet the facts of nature are connected together by so subtle and so continuous a thread, and the accidents, apparently the most devoid of significance, are so governed by general and permanent reasons, that nothing can be without interest to the meditations of a thinker, especially none of the facts which touch so closely the mystery of life.

The breeding of cattle is a real branch of industry, and a branch which has precise and rigorous rules, and connected methods. The most important of those methods is what we call the *method of selection* or of *election*. We shall explain in what it consists. When the breeder wishes to obtain the improvement of a particular kind, according to a certain fixed direction, he selects the individuals the most remarkable for the quality which he seeks; if it is size, the biggest; if height, the tallest; if nimbleness, the lightest; if cleverness, the most ingenious, the most skilful. The products resulting from that first choice will possess the qualities of their parents in a superior degree, for it is known that individual characteristics are transmitted and accumulated by inheritance. If we operate on these products as we have done on the first individuals, the desired quality will unceasingly go on increasing, and at the end of several generations we shall have obtained those beautiful breeds, all of human crea-

tion, which countries, given to agriculture, contend for, and which, by proper crossings, produce new breeds or, at least, innumerable varieties.

Well, why should not nature do what man does with his art? Why should we not admit a kind of *natural selection* which has taken place in the series of ages? Why should we not admit that certain individual characteristics, which have been originally the result of certain accidents, have been afterwards transmitted and accumulated by way of inheritance, and that by this means very different varieties have been brought about in the same species as we produce them ourselves? Let us now admit, with M. Darwin, a second principle, without which the first one could not produce all that it contains—that principle is the principle of *competition for life.* It may be explained as follows:—All created beings contend for their food; they all struggle in order to live, to subsist. Now, for a certain given number of animals there is only a certain sum of food; it is impossible, therefore, that they should all equally maintain themselves. In the struggle which takes place, the weak necessarily give way, and the victory belongs to the strongest. Only the strong survive, and establish a level between the population and the food destined for it. We recognise here the great law of Malthus, which has excited such discussion in the sphere of political economy, and which M. Darwin extends from man to the whole animal kingdom.

This law being given, and it is so beyond doubt,

let us see how natural selection acts. The individuals of a given species, which have accidentally acquired a characteristic more or less advantageous to their preservation, and transmitted it to their descendants, will be better armed in the competition for life; they will have greater chances of preserving themselves; and, when this characteristic is perfected by time, it will constitute for that particular variety true superiority over all those of the same species. Now imagine, in the surrounding medium, some change imparting, all of a sudden, a character of urgent necessity to that quality which, till then, had not been of much use, as a longer or thicker fleece would be in a sudden cooling of the temperature, the animals possessing that advantage will profit by it and subsist, whilst the others perish. It is seen that, according to this hypothesis, the adaptation will result from the coincidence between the accidental productions of an advantage perfected by inheritance, and an accidental alteration of medium.

Let us see now how, with the help of these principles, M. Darwin succeeds in explaining the origin of species. In the same given type there can be produced accidentally advantages of various kinds, and which do not compete together. Each one profits by its own, without injuring the one that has a different quality. Hence distinct varieties, well provided, though differently, for competition for life. Those, on the contrary, which have remained faithful to the original type, and have acquired no

new advantage fit to preserve them in a new medium, are doomed to death. Thus it is that the primitive type disappears; the extreme varieties subsist alone, and those varieties, becoming more and more dissimilar in course of time, are called species because the characteristic features of the common origin are lost.

We now apply this theory to an example which is not very flattering to the human species, but which is so obvious here that not to notice it would be to exhibit a false scruple. One of the greatest objections made against M. Darwin is that, if his theory is a true one, we must admit that man—most humiliating fact—has begun by being an ape; to which one of M. Darwin's disciples answers, "that he had rather be an improved ape than a degenerate Adam." Now, in M. Darwin's theory, it is not true that man descends from the ape; for, if he did, as he has over the ape a great advantage, he would have defeated him in the competition for life, and, consequently, would have absorbed and destroyed him. The fact is, that the ape and man both derive from a same type which is now lost, and of which they are diverging deviations. In a word, according to that hypothesis, the apes are not our ancestors,—they are our cousins once removed.

Let us generalise that example. We must not say that vertebrated animals have been molluses, nor mammalia, fishes or birds; but the four divisions are four distinct branches which have sprung

from the same stem. In each division the primitive type is equally diversified; and it is by these successive determinations, by this sum of differences, this accumulation of new characteristics in series which are ever diverging, that the species now living have been produced. In a word, the organised kingdom has always proceeded from the general to the particular, and as we should say in the language of logic, by increasing steadily what its comprehension contains.

Such is, I think, in its essential points, and without making any alterations, M. Darwin's system, a system which he defends with really inexhaustible intellectual resources, and especially with the most admirable sincerity; for, contrary to the way of inventors of systems who bring forward only the facts favourable to their views, and keep the others carefully hidden, M. Darwin devotes half of his volume to an exposition of the difficulties and objections which his principle may raise, some of which are so formidable that he has the utmost trouble in softening down their consequences. Has he, however, touched the leading difficulty which weighs upon the whole system, and which keeps our own mind in suspense? We think not; and we shall now endeavour to say why.

According to us, the true stumbling block of M. Darwin's theory, the perilous and slippery point, is the passage from artificial to natural selection; it is when he wants to establish that a blind and designless nature has been able to obtain, by the concur-

rence of circumstances, the same result which man obtains by thoughtful and well calculated industry. For, let us not forget that in artificial selection, man chooses the elements of his combinations, in order to reach the desired one; he selects two factors already possessing, both of them, the characteristic which he wants to obtain or to perfect. If there was some difference between the two factors, the product would be uncertain and mixed, or else, even if the characteristic of one of the factors predominated, it still would be always weakened by the mixture with a contrary characteristic.

In order that natural selection should obtain the same results, that is to say, the accumulation and perfection of any given feature, nature must be capable of making a choice; to speak plainly, the male endowed with such a feature must unite himself precisely to a female like him. In this case, I acknowledge that the multiple of the two factors would have the chance of inheriting the common feature, and even of adding to it. This multiple or product must, moreover, seek also out of his species another individual having likewise accidentally obtained the same feature. Thus, by a series of similar selections, nature might give us what human industry does give, for it would act exactly in the same manner.

But who does not perceive that I am stating an impossible hypothesis? For how can we admit that an animal having undergone an accidental modification (for instance, a shade more or less in

the colour), will just go and discover in his own species another individual likewise modified at the same time? Such a modification being originally accidental and individual, must be a rare case, and therefore the chances of two individuals meeting and uniting together are very few; the blind desire which leads the male to the female cannot have that foresight, and, if it had, what a striking example of finality! And if we suppose the impossible case of such a meeting occurring once, how can we admit that it is renewed in the second generation, then in the third, the fourth, and so on?

The variety can be produced only on condition of a constant union between two similar factors; otherwise the modifications, deviating at each new couple, will have no constant character, and the type of the species will alone remain identical. M. Darwin's adherents quote, with an air of triumph, the small space of time which human industry requires to obtain a first variety; and they say, "What cannot nature do with centuries at its disposal!" It strikes me that time has nothing to do with the present question. The whole knot of the difficulty is in the multiplication of the desired advantage—multiplication which requires a selecting thought.

The human species itself offers instances of variation produced by selection; but this fact originates from constant and repeated unions between similar subjects. Thus the Jewish type is well-known, and has persisted still after the lapse of

ages, in spite of the changes of medium; but then the Jews intermarry, and thus preserve the distinctive features which characterise them. I suppose the case of mixed marriages—suppose that, prejudices, wearing away, the Jews were to marry with the other portions of the population; how long, then, would the Jewish type last? It would speedily be absorbed and transformed. There is, near Potsdam, says, M. de Quatrefages,* a village particularly remarkable for the height of its inhabitants. What is the cause of this singularity? It is owing, we are told, to the fact that the father of Frederick the Great, who was fond of tall men, selected the tallest peasant girls whom he could find for the purpose of marrying them to his grenadiers. This, we must not forget, is essentially a case of artificial election. Thus Plato, in his Republic, whilst prescribing that husbands should be drawn for by lot, nevertheless advised the magistrates to cheat a little, and, without appearing to do so, to join the handsomest woman with the handsomest man, in order to obtain vigorous citizens. We see, by all these examples, that election always supposes a common character in both sexes; now this cannot take place in nature, this character, which is quite accidental, being in the first place very rare, and the individuals possessing it at the same time, having no reason to meet and to choose one another.

I know that M. Darwin distinguishes two kinds of artificial selection, the one which he calls

* See *Revue des Deux Mondes*, for April 1, 1861.

methodical, the other which he designates as unconscious. The methodical selection is that of the breeder, who combines his elements as, in mechanics, we combine the different parts of a machine. The unconscious selection is that by which we obtain the amelioration or modification of a species without having precisely sought that result; it is the case of a sportsman, for instance, who has not the slightest pretension to perfect the canine race, but who is led, by taste, to choose the best dogs he can procure, and obtains, through the force of circumstances, an accumulation of qualities in that class of animals. Thus it is, probably, that the various breeds of dogs have been produced. There is no systematic method there, and yet the result is the same, although slower. The same thing takes place in nature, according to M. Darwin. It exercises an unconscious selection, and the struggle for life is the agent which here stands instead of choice. Those who have the greatest number of advantages triumph necessarily by the right of the strongest, and nature has thus spontaneously and unwittingly set aside the individuals the most gifted or the best adapted to resist the action of the medium in which they are placed.

We are now in the very heart of the system. That we may well appreciate it, let us distinguish two different cases: either the surrounding medium does not change, or it does. What will happen in both these hypotheses? We must notice here a great difference between Lamarck's doctrine and

that of M. Darwin. According to the former, so long as the medium does not change, the species remains unaltered, when once it has been adapted by habit to that medium; for, having what it requires in order to live, we do not see why it should make an effort to modify its condition. But if the alteration is produced by natural selection, it ought to be able to manifest itself even in an invariable medium, because, however well adapted a species may be, we can yet conceive of its becoming still more so; certain accidents can still produce themselves, which would secure to certain individuals an advantage over others, and would open for them, so to say, a wider field. And thus we do not see why, in this hypothesis, the species could not vary under our own eyes. It even strikes us that infinite time need not be required for the purpose, when we think of the quickness with which human industry creates fresh varieties.

Why, then, do we not see such modifications produced? It is because the principle of natural selection, even united to that of the struggle for life, cannot have, it appears, the virtue ascribed to it by M. Darwin. For, let us suppose that in tropical countries the colour is an advantage which renders the inhabitants better fitted to bear the heat of the climate; suppose that, in one of these countries, there are none but white people, and that, at a given moment, one of the individuals is accidentally of a black colour; that individual will have an advantage over his fellow countrymen—he

will live longer, if you please. But he marries. Whom will he marry? a white woman, no doubt—the black colour being an accident. Will the child resulting from this union be black? No; of course he will be a mulatto; the child of the mulatto will have a complexion still less dark; and in four generations the accidental colour of the first individual will have disappeared, and mingled with the common characteristics of the species. Thus, even in admitting the black colour to have been an advantage, it would never have had time to perpetuate itself enough in order to form a new variety better qualified for the climate, and thereby calculated to gain the mastery over the whites in the struggle for life.

If there were any doubts on the merits of the argument which I adduce here against the significance of M. Darwin's principle, I might invoke the authority of another naturalist, M. de Quatrefages, who yet is very favourable to that principle. He names several individuals of the human species who have been accidentally gifted with exceptional characteristics, and he wishes to explain how these individuals have not produced new varieties. "No Lambert," says the naturalist, "no Colburn (such are the names of the abnormal individuals in question), has united himself to another individual presenting the same anomalies as himself. The selection tended here to efface the excessive and preternatural activity of the skin, or the exaggerated number of the fingers. At each generation the

influence of the abnormal primitive fact diminished necessarily by the admixture of the normal blood: it must have finished by promptly disappearing." Further on, M. de Quatrefages explains, by the absence of artificial selection, the relative uniformity of the human groups compared with the domestic animals. Does it not follow that natural selection is insufficient to make the species vary, for the cogent reason which I have already so often adduced —that the different individuals of both sexes, accidentally presenting the same characteristics, will not be able to meet?

I do not contest the principle of natural selection nor that of vital struggle. These two laws are very true, but it seems to me that they must act in a direction altogether different to that which is announced; they must do a great deal more to preserve them to modify the species. For, as the kind of life of an animal always depends upon his structure (whether or not we admit final causes), it is evident that in the same species the animals enjoying the greatest advantages are those whose organisation is most conformable to the type of the species. In the carnivorous animals, for instance, the advantage will be for the one which has good claws, strong teeth, supple and vigorous muscles. If you suppose a modification intervening which might ultimately be an advantage under other conditions, it will nevertheless be an inconvenience at its origin by altering the type of the species, and thus rendering the individual less fit for the kind of

life to which his general organisation calls him. Suppose, in an herbivorous animal, the flat teeth so well adapted to masticate tender herbs, accidentally replaced, for some individuals, by teeth qualified to cut; although the cutting tooth is really an advantage for the species which have it, because it allows them to enjoy two kinds of food, yet it would be a very great disadvantage for the individual possessing it accidentally, because he would thereby be less able to find his usual food, and nothing in him would be prepared with reference to nourishment of another kind. I conclude that natural selection must have for its effect, in a medium always the same, to maintain the type of the species, and to preserve it from alteration; on the other hand, I cannot see here, unless it be accidentally, a principle of modification and of change.

Is it the same case when the medium itself is altered—when, by any causes, the external circumstances happen to vary? It is, then, if we believe M. Darwin, that the principle of natural selection acts in an all-powerful manner. For if, at the moment when the alteration takes place in the medium, some individuals of a species happen to have precisely certain characteristics rendering them fit to live in that medium, is it not evident that such individuals will enjoy a great advantage over the others, and that they will survive whilst the others perish? Through the action of natural selection a characteristic feature, originally accidental, might therefore become a specific one.

It is evidently here that M. Darwin's hypothesis presents itself with the greatest advantage; but it is still surrounded by very considerable difficulties. We must admit, in the first instance, that the modification in question has occurred at the same time and in the same place in several individuals of both sexes. For, as we have already shown, if it does not exist simultaneously in both sexes, this quality, far from accumulating and manifesting itself with greater distinctness through inheritance would unceasingly become weaker, and no new species could be produced. Here is, then, one first union, one first coincidence which we must admit. In the second place, we must suppose that each animal species has had for its origin the coincidence of an accidental modification with an alteration of medium, thus multiplying *ad infinitum* the number of coincidences and of accidents. In this hypothesis, whilst a certain series of causes made the organic forms vary according to particular laws, another series of causes, according to other laws, brought about the alteration of the media. The fact of adaptation in animals, then, is nothing else but the point of contact between these two series. Now, as in the organism, the forms adapted to their various purposes are numbered by hundreds of millions—or, rather, are innumerable; we must admit that these two series of parallel causes have met in agreement hundreds of millions of times, or rather for an inappreciable number of times; in other words, we must abandon to fortuitous cir-

cumstances, not to say to chance, the principal share in the development and the progress of the animal scale. Is that, indeed, a rational explanation?

Here is, finally, a difficulty which strikes us as one of the gravest. In his zoological philosophy, Cuvier has laid great stress upon the law of organic correlations, as he calls it. According to this law, the organs are connected together by logical relations, and the form of each is determined by the form of the rest. It follows that certain combinations of organs are impossible, whilst others are necessary. Every one knows that by means of this law Cuvier founded the science of palæontology; from one bone, or even from a fragment of a bone he deduced *à priori* in a fossil animal all the missing ones. It follows from thence, that if a leading organ undergoes an important modification, in order that the equilibrium may subsist, it is necessary that all the other essential organs should be modified in the same manner. Otherwise, a local change, how advantageous soever it may be *per se*, will become injurious, from its disagreement with the rest of the organisation. If, for instance, the scales of the fish could, as Lamarck believed, become transformed into the wings of birds (and Cuvier declared this hypothesis to be absurd from the anatomical stand-point), it would be necessary at the same time for the swim-bladder in the same fishes to be transformed into lungs, and this appears to M. Darwin the most striking instance of his theory.

Well, without examining the intrinsic merit of the facts, I maintain that these two correlative and parallel transformations cannot be explained on the supposition of a simple accident. M. Darwin seems as if he had wished to anticipate this objection by admitting what he calls a correlation of growth. He acknowledges that there are connected and sympathetic variations, that there are organs which vary at the same time and in the same manner:—the right and the left side of the body, the anterior and posterior limbs, the limbs and the jaw. But this law does not remove the difficulty. We must select one of two suppositions. Either this law is altogether a mechanical one, indicating mere geometrical relations between the organs, and having no reference to the preservation of the animal; and then it is of no use towards the solution of the problem I have stated; or else, these correlations of growth are precisely those required by the alteration of the medium or of the external circumstances, and then, how can we understand them without a certain finality? By what singular law, organs which can act only by agreement together; could they modify themselves at the same time and in the same manner, independently of some prevision on the part of nature? Here again the mere combination cannot explain everything.

Hitherto, we have satisfied ourselves with offering a few general and abstract considerations on the possibility of the system we are discussing, leaving to naturalists the case of verifying if the

facts agree with that hypothesis. We shall endeavour, however, in order that we may render our criticism a little more precise, to apply it to a few special cases. We shall select as our example M. Darwin's theory on the formation of the eye in the superior animals, and his theory on the formation of the instincts. In both cases the hypothesis seems insufficient to account for the facts presented by observation.

M. Darwin wants to explain by the law of natural selection, or by a succession of accidental modifications, the formation of the eye, that is to say, of the most perfect of optical instruments. As we have already stated, he is, himself, frightened by the task he has undertaken.

"To suppose that the eye, with all its inimitable contrivances for adjusting the focus to different distances, for admitting different amounts of light, and for the correction of spherical and chromatic aberration, could have been formed by natural selection, seems, I freely confess, absurd in the highest possible degree..... Reason ought to conquer imagination; though I have felt the difficulty far too keenly to be surprised at any degree of hesitation in extending the principle of natural selection to such startling lengths."*

Let us endeavour, then, agreeably to M. Darwin's example, to overrule our imagination, and let us follow him in the explanation he gives us of the formation of the human eye. The fact from

* *Origin of Species*, pp. 187, 188.

which he starts is the gradation of the shape of the eye in the scale of the animal kingdom. It is not immediately and without any transition that nature reaches unto perfection in the structure of the organ of sight; it is by a series of steps, each of which may be an improvement upon the previous one. Suppose, first, a simple optical nerve sensible to light: that is a starting point which we can grant without appealing to any final cause. For, the innumerable combinations of organised matter at a certain given time, may render an organ sensible to light, just as we render the prepared plate in the Talbotype sensible to the chemical action of the rays of the sun. Such a fact, we say, can certainly result from the concurrence of causes. Now, this point once granted, we can admit that the nerve endowed with this wonderful property undergoes, in various circumstances, an infinite number of modifications, some of which are useful, and others indifferent or even injurious, to the animal. The injurious ones must, in the long run, constitute an inferiority for the species in which they are fixed; and *vice versa*, the advantageous modifications procure an evident superiority to the species endowed with them. The former tend to bring about the destruction of the less favoured species; the latter are, on the contrary, a cause of duration and of persistence. It follows that the former must disappear, and the latter become indefinitely more and more perfect. Consequently, a very great number of degrees of transition in the structure of the

eyes must have already vanished without leaving any traces behind, and yet a very great number still remain, as it can be seen in the treatises of physiologists, chiefly those of Müller, who has studied the question most deeply. In following this series of degrees, we can rise from the simplest and most imperfect eye to the most complicated one. Why should we not admit that nature has followed equally the same process?

We must acknowledge, indeed, that the animal kingdom presents a very great diversity in the structure of the eyes: Müller arranges these under three principal classes. The first includes the simple eyes or occular points, consisting merely in a kind of nervous bulb, without any optical apparatus, and the use of which seems to be solely to distinguish night from day. Then, he points out to two different systems having, however, this feature in common, that they are both optical apparatuses, adapted for the perception of images, but founded upon distinct principles. The former is the system of compound eyes, arranged in the shape of facets or mosaïc work, and which are to be found chiefly in the insects and crustacea; the latter is that of lens-shaped eyes, occurring in superior animals and even in a few inferior ones. The former system consists, according to Dr. Müller, in placing before the retina, and perpendicularly to it, an innumerable quantity of transparent cones, which allow the light to reach the nervous membrane only in the direction of their axis, whilst they absorb by

means of the black pigment with which the sides are coated, every ray of light which strikes them obliquely. As for the latter system, it consists in substituting to these cones lenses called *cristalkines*, which, when plunged in damp media, have as well as these media the property of making the rays of light converge, and of concentrating them on the retina. These two systems offer, then, the one isolating, the other, converging, apparatuses, but all in perfect agreement with the laws of optics.

These facts once established, what conclusion must we draw from them? Let us observe, first, that the fact of gradation in organic forms, has nothing contrary to the principle of finality. In assuming the existence of a creative or regulating Mind, what more natural, what wiser law can there be than that of insensible and continuous progress? The very idea of progress seems to indicate the preconceived notion, or, at any rate, the instinctive presentiment of perfection. To say that perfection results from the progressive complication of phenomena, is to confound perfection with complexity—two ideas very different from each other. It seems, on the contrary, that in proportion as the phenomena become more mixed up together, it becomes more difficult to obtain a methodical and regular effect. In the game of *spellicans*, throw three of the pieces on a table; it is not impossible, as they fall, that they may combine so as to form a triangle; but if you throw a hundred of them, there are thousands of chances against their producing a

regular figure. If then you suppose the eye formed by an infinite addition of phenomena, the chances are infinitely greater for its being altered or destroyed than for its being perfected.

But, in addition, the gradation is very far from absolute. Between the two superior systems, viz.: the isolating one and the converging one, we see that there can be, strictly speaking, a transition and a passage. M. Darwin quotes, indeed, cases where the transition does take place, and where the cones of the former system assume the lenticular shape which characterizes the latter; but the truly important fact is the transition between the first system and the two others; now, it is here that neither he nor Dr. Müller can produce any example. How can we rise from occular points, from mere nervous swellings, sensible to light, to the optical apparatuses, either conical or lenticular, which, affecting geometrical forms, become fit for the perception of images? Müller here mentions only two or three facts of a very doubtful and very badly defined signification. For want of instances, M. Darwin gives us an hypothesis. "If we must compare the eye to an optical instrument," he says, "we ought in imagination to take a third layer of transparent tissue, with a nerve sensitive to light beneath, and then suppose every part of this layer to be continually changing in density, so as to separate into layers of different densities and thicknesses, placed at different distances from each other, and with the surfaces of each layer slowly changing

in form."* What a number of suppositions and of coincidences we must admit here! But, even if we grant these transformations, we have only accounted—and this is worthy of remark—for the variation from the first to the third system, that is to say, from the simple to the lenticular eyes. Now, between these two systems, we find, in the case of the greater part of invertebrata, the mixed system of facet or mosaïc-shaped eyes, belonging to the insects and to most crustacea; and M. Darwin's hypothesis can in no way account for the structure of the third system. For, how can transparent cones with dark sides be produced by the slow and imperceptible change in the density of the media, and the alteration in the form of the surface of these media? This combination, quite as scientific as that of lenticular eyes, itself requires an hypothesis in order to be explained.

Notice, besides, that in these two great systems which merge into one another by imperceptible transitions, there is still an optical apparatus, and consequently, the accomplishment of a plan and a design. In order to prove the contrary proposition, it would be necessary to show that amongst all these apparatuses there are many which have been constructed in opposition to the laws of optics, that is to say, which have accidentally assumed geometrical forms, useless or injurious to vision. It would be necessary to point out to transparent cones without dark sides, and, consequently unfit

* *Origin of Species*, pp. 188, 189.

for the function assigned to them by Müller, and, despite all their complications, rendering no more services than mere occular points. It would be necessary to show us eyes with concave crystallines instead of convex ones, dispersing the rays of light instead of condensing them; it would be necessary to show media with a density inferior to that in which the animal is placed. Such are the contradictions which it would be necessary to offer, and to offer in large numbers, if our objectors wished to render plausible the formation of the eyes by an insensible succession of accidental modifications. It is evident that if the eyes have not been made for the purpose of seeing, a very great number of modifications must have been produced having no connection with the function of sight. It is too easy to answer that all such modifications have disappeared; for it would be strange, indeed, that so many forms having existed, only those remain which are appropriated to their functions. If we say that these modifications, being disadvantageous, have brought about the extinction of the races which had them, we exaggerate very much, it seems to me, the importance of such and such a degree of vision. Since we find that many animals can live with mere occular points, without any optical apparatus, it is not easy to understand why they could not live with useless or badly-constructed apparatuses. This disadvantage in the organs of sight might, in many cases, be compensated by the superiority of other organs, and not

necessarily be a cause of destruction. Those, then, are the facts which it behoves our objectors to quote, in order to prove that the eye has been produced by mere physical causes and without any forethought; for it will be useless to adduce innumerable kinds of eyes; if they are eyes, that is to say, organs serving to see with, the principle of final causes remains untouched.

I pass on to the question of instinct. Lamarck's theory on that point is well known. Instinct, according to him, is an hereditary habit. M. Darwin adopts this theory, modifying it by the principle of natural selection; the same thing, he remarks, can be said of the instincts as of the organs. Any modification in the habits of a species can be advantageous, just as much as the modification of its organs. Now, when an instinctive modification has taken place in a species, it will tend to perpetuate itself; and, if it is beneficial, it will secure to those enjoying it the advantage over all the other varieties of the species, so as to destroy all the intermediate varieties. We cannot, indeed, prove by direct observation that the instincts have been modified; but some indirect observations seem to justify this hypothesis; for instance, the gradation of instincts. Thus the making of honey by the bees presents to us three types, distinct, but united together by imperceptible gradations: first, the humble-bees which make their honey and their wax in the hollow of trees, then, the hive-bees which, in the construction of

their cells, have solved a problem of transcendental mathematics, and finally the Mexican bees, forming a kind of medium species inferior to the hive-bee and superior to the humble-bee. Cannot we see here the trace and indication of a development of instinct, which, starting from the lowest degree, has gradually arrived to the point where we now see it? A fact which justifies this conjecture is, that if we interfere with the industry of the bees, if we place it in unfavourable or new conditions, we can succeed in making them alter their habits and their modes of operation. A number of experiments carried on in that direction might throw considerable light on this obscure question.

I do not hesitate to acknowledge that the theory which explains instinct by hereditary habits should not be cast aside without a thorough investigation; but there are very serious difficulties even there. In the first place, the diversities of instinct which might be noticed under certain special circumstances, would not necessarily be conclusive against the hypothesis of a primitive instinct peculiar to each species; for, even on that hypothesis, nature, having given to the animal an instinct necessary for his preservation, may have wished, in its forethought, that this instinct should not be deficient precisely as soon as the slightest alteration took place in the external circumstances. A certain degree of flexibility in the instinct is quite compatible with the doctrine of an irreductible instinct. For instance, nature having given to the bird the instinct of

constructing its nest with certain materials, cannot have wished that the bird should build no nest if such materials were wanting. As our habits, be they ever so mechanical, are yet *automatically* modified, as soon as any external circumstances disturbs them, it might be exactly the same case for natural instincts or habits originally stamped upon the very organisation of each species by the provident Author of all things.

I shall raise, besides, a serious objection against the application of the principle of natural selection to the formation of instincts. According to M. Darwin, the modification of instinct which has been accidental at first, has afterwards transmitted itself and become fixed by inheritance. But what is the accidental modification of an instinct? A fortuitous action, of course. Now, can a fortuitous action be hereditarily transmitted? Notice the difference there is between the modification of an organ and that of an instinct. The former, be it ever so slight, so superficial, as the mere colour of a plumage, is permanent and lasts for life: it is stamped in a durable manner upon the organisation, and we can understand its being transmitted by inheritance; but an instinct is only a series of given acts. A modification of instinct, then, is a particular action which comes fortuitously to add itself to the series. How can we believe that this action, even if it was several times repeated by chance in the course of life, could be reproduced in the series of the actions of the

animal's descendants? We see fathers transmitting, to their sons habits they have contracted (and even then we must allow for imitation, and for the similarity of media); but we do not see that the son reproduces the accidental actions of the father. What a number of facts must our opponents quote in order to render credible so strange an hereditary transmission!

If one doubted that M. Darwin assigns so great a share to chance in the origin of instincts, I might recal the example he quotes himself, namely, the instinct of the cuckoo. We all know that the female bird lays its eggs in a nest which is not her own. This instinct, peculiar to the European cuckoo, does not belong to the American one. M. Darwin supposes that the European cuckoo may have formerly had the same habits as that of America. "Let us suppose," says he, "that the ancient progenitor of our European cuckoo had the habits of the American cuckoo, but that occasionally she laid an egg in another bird's nest. If the old bird profited by this occasional habit, or if the young were made more vigorous by advantage having been taken of the mistaken maternal instinct of another bird, than by their own mother's care, encumbered as she can hardly fail to be by having eggs and young of different ages at the same time; then the old birds or the fostered young would gain an advantage. And analogy would lead me to believe, that the young thus reared would be apt to follow by inheritance the

occasional and aberrant habit of their mother, and in their turn would be apt to lay their eggs in other birds' nests, and thus be successful in rearing their young."*

We have clearly here an accidental and fortuitous action considered as hereditarily transmissible. Now I ask zoologists if they grant that the power of inheritance can go so far.

In order to appreciate correctly the theory of hereditary habits, it would be necessary to collect and discuss a great number of facts. I shall quote only one which seems to be absolutely repugnant to all theory of the kind. It is the instinct of the *necrophori*. When these animals have laid their eggs, they are in the habit of going to seek the dead bodies of other animals, and of placing them by the side of the eggs, in order that the young ones may have food as soon as they are hatched; some even lay their eggs within the carcases themselves. Now, the incomprehensible part of the case is this: the mothers, possessing this instinct, will never see their young ones, and have never seen their own mothers; they cannot, then, know that the eggs will become animals like themselves, nor can they, consequently, foresee their wants. Amongst other insects, the *pompilidæ*, the instinct is still more striking. In this species, the mothers have habits of life quite different from that of their young; for they are herbivorous, whilst the larvæ are carnivorous. They cannot, then, from their

* *Origin of Species*, p. 217.

own example, infer what will be suitable for their offspring. Is hereditary habit here appealed to? But that instinct must have been originally perfect, and it is not susceptible of degrees; a species not having that instinct precisely such as it is now could not have subsisted, because the young ones, being carnivorous, require absolutely animal food ready prepared for them as soon as they are hatched. If you say that the larvæ were originally herbivorous; that fortuitously and without any purpose the mother, attracted, perhaps, by a particular taste, has gone and laid her eggs in a carcase; that the young ones born in that medium, have gradually accustomed themselves to it, and become carnivorous from herbivorous, which they originally were; then, that the mother herself has lost the habit of laying her eggs in carcases, but that, by virtue of the association of ideas, she has continued to go in quest of those carcases now useless for her, and has placed them near her eggs—and all this without any design; you multiply to so fearful an extent the number of fortunate accidents which may have brought about such a result, that the confession of ignorance would, it seems to me, be far better.

We shall conclude by a general observation. Notwithstanding the numerous objections we have raised against M. Darwin's theory, we do not directly declare ourselves hostile to a system of which zoologists are the only competent judges.

We are neither for nor against the transmutation of species, neither for nor against the principle of natural selection. The only positive conclusion of our debate is this: No principle hitherto known, neither the action of media, nor habit, nor natural selection, can account for organic adaptations without the intervention of the principle of finality. Natural selection, unguided, submitted to the laws of a pure mechanism, and exclusively determined by accidents, seems to me, under another name, the chance proclaimed by Epicurus, equally barren, equally incomprehensible; on the other hand, natural selection, guided beforehand by a provident will, directed towards a precise end by intentional laws, might be the means which nature has selected to pass from one stage of being to the other, from one form to the other, to bring to perfection life throughout the universe, and to rise by continuous progress from the monad to man. Now, I ask M. Darwin himself, what interest has he in maintaining that natural selection is not guided—not directed? What interest has he in substituting accidental causes for every final cause? I cannot see. Let him admit that in natural as well as in artificial selection there may be a choice and direction; his principle immediately becomes much more fruitful than it was before. His hypothesis, then, whilst having the advantage of exempting science from introducing the personal and miraculous intervention of God in the creation of each species, would yet be free from the danger of banishing

out, of the Universe an all-provident thought, and of submitting everything to blind and brute chance.*

Two theories of the world and of nature, radically different from each other, are now in opposition. According to the one, the world is only a descending series of causes and of effects; something, in the first place, has existed from all eternity, with certain primitive properties. From these properties certain phenomena result; from these phenomena combined, fresh phenomena originate, giving birth to other phenomena, and so on *ad infinitum*. It is these unforeseen descents and deflections which helped by unlimited time, produce the world which we see. According to the other view, the world may be compared to a living and organised being, developing itself in agreement with an idea, and

* There is no contradiction in admitting together with the principle of natural selection, a principle of finality. A distinguished botanist, M. Naudin (recently elected member of the *Institut*), and who, even before M. Darwin, had compared the plastic action of nature in the formation of the vegetable species, to the systematic selection of man, acknowledges that natural selection is insufficient without the principle of finality. "A mysterious, undetermined power," says he, "called fatality by some, by the others, providential will, whose unceasing action upon living beings assigns, in every epoch of the world's existence the form, the volume, the duration of each one of them relatively to its destiny in the order of things of which he is a part! That power it is which harmonises each member with the whole by adapting him to the function he has to discharge in the general organism of nature,—function which is for him the reason of his existence."

rising, by degrees, to the accomplishment of an ideal pattern, eternally unattainable in its absolute perfection. Each degree is brought about, not only by the preceding one, but by the one which follows; it is in some sort determined beforehand by the very effect it is appointed to produce. Thus we see nature rising from brute matter to life, from life to feeling and to thought. In this hypothesis, nature is no longer a kind of game where, all things happening by chance, some effect is produced, whatever that effect may be; it acts conformably to a plan, a reason, a thought. It is not a kind of extempore and chance game of cross purposes, where an apparent conversation might result from a series of independent discourses; it is a poem, a drama skilfully conducted, and where all the threads of the action, how complex soever they appear, are, nevertheless, connected towards a fixed purpose. It is an ascending series of means and of ends.

How can these two series be reconciled and united? How can the connection of causes and effects become a connection of means and of ends? How can the mechanism of nature realise the ideal law which the mind requires? How can the mind, in short, at once go up and down, so to say; at the same time descending from cause to cause, and ascending from end to end? The only solution of this mysterious antinomy is the following one: a first thought has selected and directed everything. Out of the infinite number of directions towards which the Universe might have been hurried on by the uncon-

scious and irregular play of mechanical causes, one has prevailed. As a runaway horse carried on by blind impetuosity in his reckless career might follow a thousand various directions, but under the guidance and authority of a skilful rider, takes only one course, which leads him to the appointed end; so, blind nature, constrained from the beginning by the power of an incomprehensible will, and directed by an unknown Master, is everlastingly progressing by a graduated movement, full of greatness and of splendour, towards the eternal ideal the desire of which possesses and animates it.

Thought governs the world; it is at the beginning, the middle and the end; nothing is produced which is destitute of thought; but is thought itself *immanent* in the world, as the Germans say, or separate from it? Does it govern things from within, or from without? Does it know itself, or does it merely aspire at being, one day, self-conscious? Does God exist, or is He, as some have said, in course of evolution? Is He a real Being, or an ideal that can never be realised? For our part, we do not hesitate to think that an ideal can be a principle only on condition of its existing; thought must know where it is going, in order to reach its end. Between the doctrine of fatalist mechanism and that of Providence, we see no intelligible and satisfactory medium. Many persons, in the present day, would conceal from themselves the movement which is hurrying them on towards

atheism, by ascribing to nature a life, an instinct, a soul, and by endowing this soul with an unconscious tendency to what is good. I think they are mistaken; but this is not the place to combat them. Let us conclude with them against the champions of a blind mechanism, that an unknown law directs the progress of things towards an end unceasingly receding, but the absolute type of which is precisely the very cause from which the stream once of old issued forth by an incomprehensible operation.

THE END.

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